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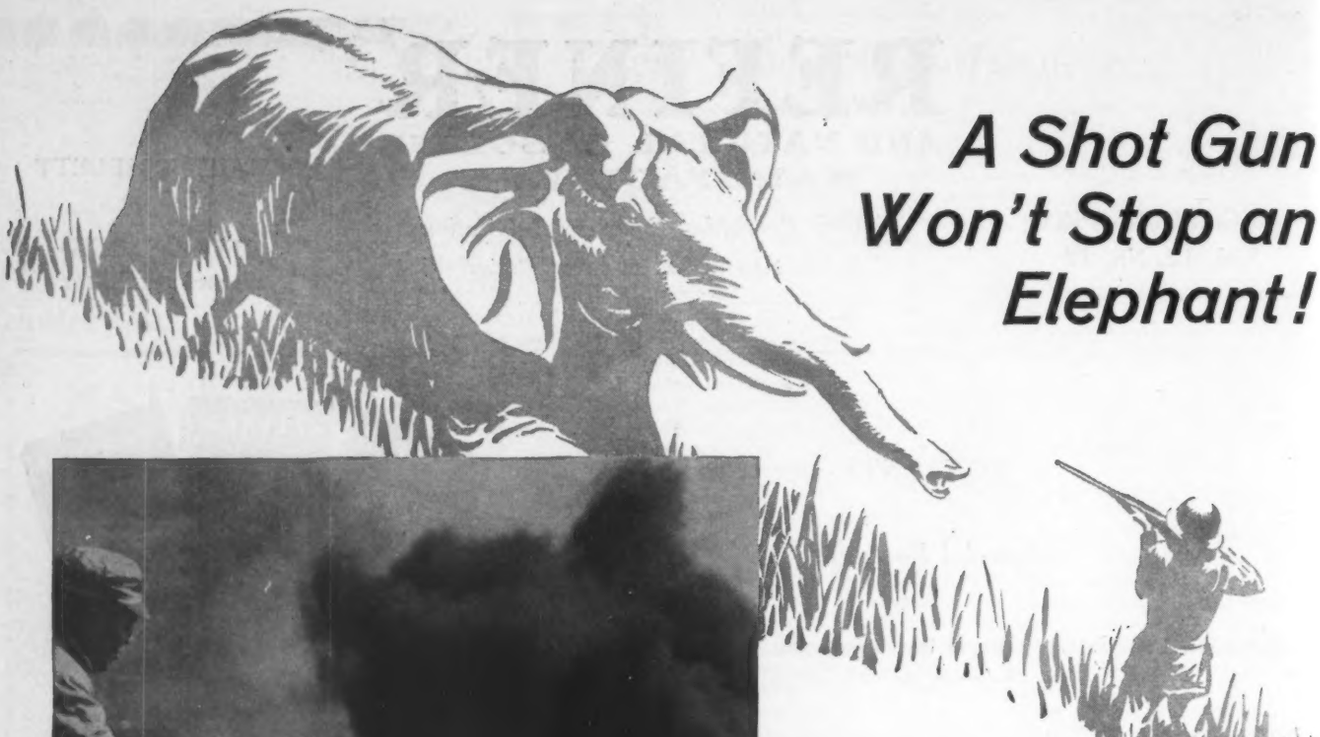

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VOLUME 12, No. 12 DECEMBER, 1933

The Refinery Is the Federal Control Instrument . . .

PRICE fixing and production control through allocation have been such alluring subjects that little attention has been given to the place the refinery holds in the administration of the petroleum industry. Yet it is the refining plant, the big one and the little one, which statisticians in Washington study and then prepare the reports out of which industry control is determined. A part of the testimony of J. Howard Marshall, assistant solicitor of the Department of the Interior before a recent commission hearing in Texas, was:

"The Bureau of Mines obtains weekly reports of the statistical position of every refinery in the country. If this report shows that stocks and storage are increasing, then it is apparent that there must be too much production at the source of supply from which this refinery derives its oil. If these stocks are decreasing, then it is assumed that this particular production is too low."

In going to the refinery as a source of information for control the men in Washington have given the industry an indication of what may be used later as well as a reference to what could have been done in the past. Somehow the petroleum industry has been forced to accept control from the element least disposed to provide sensible control.

The drilling of oil wells became the control in its early stages and neither refining nor selling ever could supplant it. When a well was completed, a pipe line was laid to it in great haste and the oil started for the refinery without consideration of the status of refinery storage or profit on sales. Refineries were supposed to accept whatever production could be provided. In turn the bulk plants and the service stations were supposed to accept whatever amount of finished products the refinery could provide.

That status came to be known as "volume minded." More barrels meant more gallons and more gallons called for more outlets. Thus the petroleum industry was not prepared for the price drop that started in 1930. It was geared for volume and not for profit.

If and when the petroleum industry is handed back to private control it is to be hoped that the red ink of the past three years has been enough to make the industry profit minded. Big and little, the concerns engaged in this business should retain what Washington is using. Instead of having one man to gloat over a mounting production while another is troubled with overflowing gasoline tanks, reports of this nature should come into one office. Such a procedure would at least give a corporation a chance to know that it faced a problem rather than a triumph and a disaster.

One of the permanent benefits of control by government should be the permission of industry to confer to an extent sufficient to know what it is about. The anti-trust laws may have been responsible in part for the way the oil well has determined the conduct of the industry in the past. But that will not prevail if there is any benefit in the temporary control by government. Amendments should be at hand to allow an industry to plan its way through periods of overproduction.

What the industry is seeing now should be stored as a lesson on what can be done with private control again possible. If by watching the tanks at each refinery the federal government can know what to do about well output, then the control the industry will have later can use similar information to determine what to do not only about production but about any other problems, some of them old and others that will come along just to plague an industry.

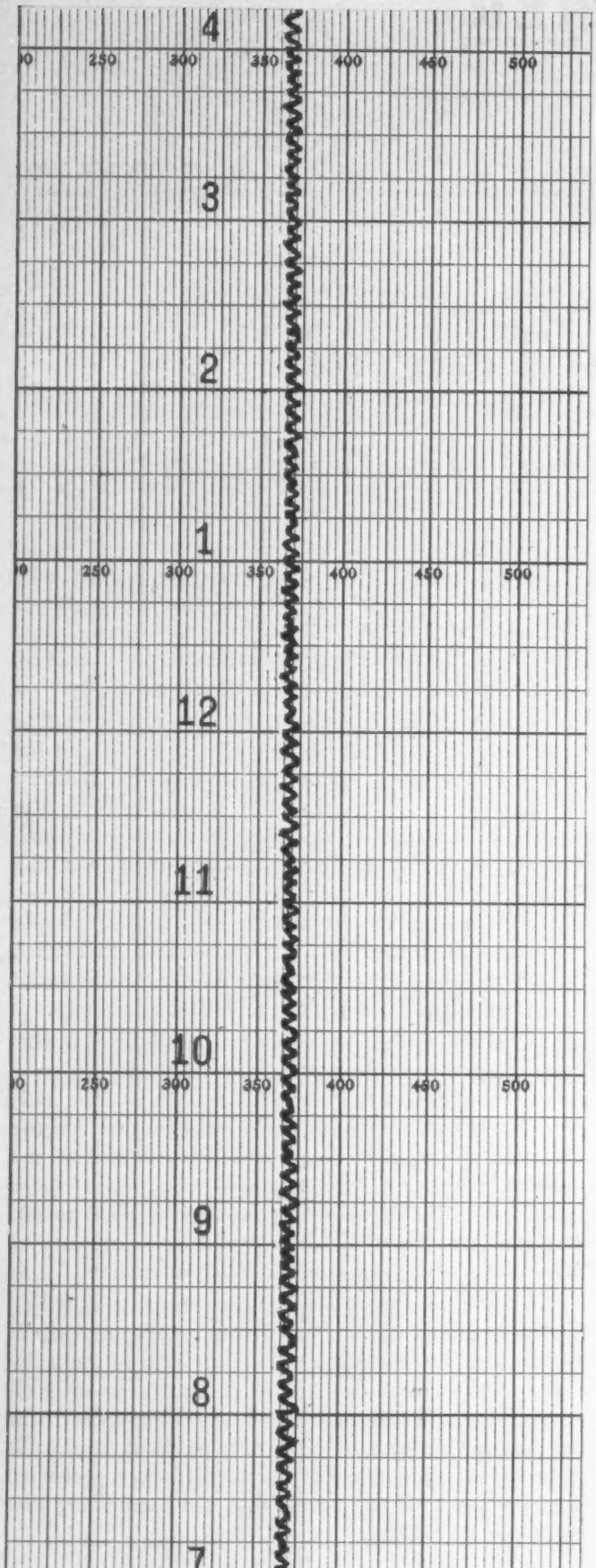

CHART I.
Two-position control on bubble tower.

Automatic Control in

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Electrical Engineer
and
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Instrument Engineer
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THE trend in oil refining is to larger and more complicated process units with the result that hand control is virtually out of the question. The large throughputs make it an economic necessity that these units be controlled as nearly as possible at their point of maximum efficiency. Deviations from optimum conditions result in decreased yields, shortened runs and departure from the desired specifications in the products. Of course it must not be inferred that these units are wholly automatic but the most modern refining process units have their most important variables such as flows, furnace temperatures, outlet temperatures and tower levels held within very close limits by automatic devices. Any control that will increase the yield by a fraction of one percent even though of high first cost will be paid for by the increased yield in a remarkably short time.

With these large units shutdowns, whether due to emergencies or to operating conditions, are of extreme importance as the time out of service and cost of cleaning have a great bearing on the cost per gallon or cost per barrel of the product. While the cost of cleaning is nearly constant each time, if the time between cleaning periods can be lengthened then costs have been lessened, provided the throughput can be held to normal. By keeping the variations of the unit at a minimum proper controls tend to prevent coking and thus lengthen the run while at the same time the danger of tube losses and emergency shutdowns is lessened. Controls also effect a reduction in operating expense by the fact that by their use the number of the operating staff may be reduced.

Just where controls are located or what they must control depends upon the individual unit they serve. But they can control temperature by regulation of the quantity of the fluid introduced into the system directly or through closed coils at a temperature greater or less than the temperature of the system such as trimming coils or tower tops, mixing tanks

Temperature Oil Refining

or reboilers. They may also regulate temperature by controlling the furnace fuel supply either indirectly from a primary element placed in the furnace to control hot oil outlet temperatures or directly by placing a primary element in the hot oil itself.

In making a study of the proper control to use it is well to separate it into two parts; one of the primary element and the other of the control itself. The primary element may be defined as the part exposed to the temperature which it is desired to control[1]. It may be either self contained or may operate through relays and power mechanisms to obtain the desired results.

Under the former class are bi-metallic strips and fluid filled bulbs and bellows systems. Self contained elements or controllers as they really are do not indicate temperature although they may have some form of scale which is primarily a tell tale of operation. In all of these the control point can be changed, generally by the cut-and-try method, and in some cases this resetting is rather difficult. Their use is for those conditions where a close control is not required. They are simple, inexpensive and easily installed. Moreover they perform satisfactorily if the job is within their power. However the power of this type of control is limited. Thus it will be seen that these have application only where an open and shut condition of the control will suffice, where refinement of control is not required and where the device being controlled does not demand much power to operate.

Under that class of primary elements that actuate controls indirectly the most common are bi-metallic strips, thermometers, thermocouples, radiation elements and resistance thermometers, all of which may be adapted for use with either air or electric motive controls.

Bi-metallic strips used thus actuate a relay which may be fluid, air or electric type. However this type of element is but little used in refining work due to its inherent thermometric lag and mechanical difficulties.

The most common thermometers used are the pressure spring types usually designated by the "filling" of the tube system, such as "liquid expansion", "vapor-pressure", and "gas-filled".

Thermocouples embrace a wide range of metals and alloys used and temperatures that can be meas-

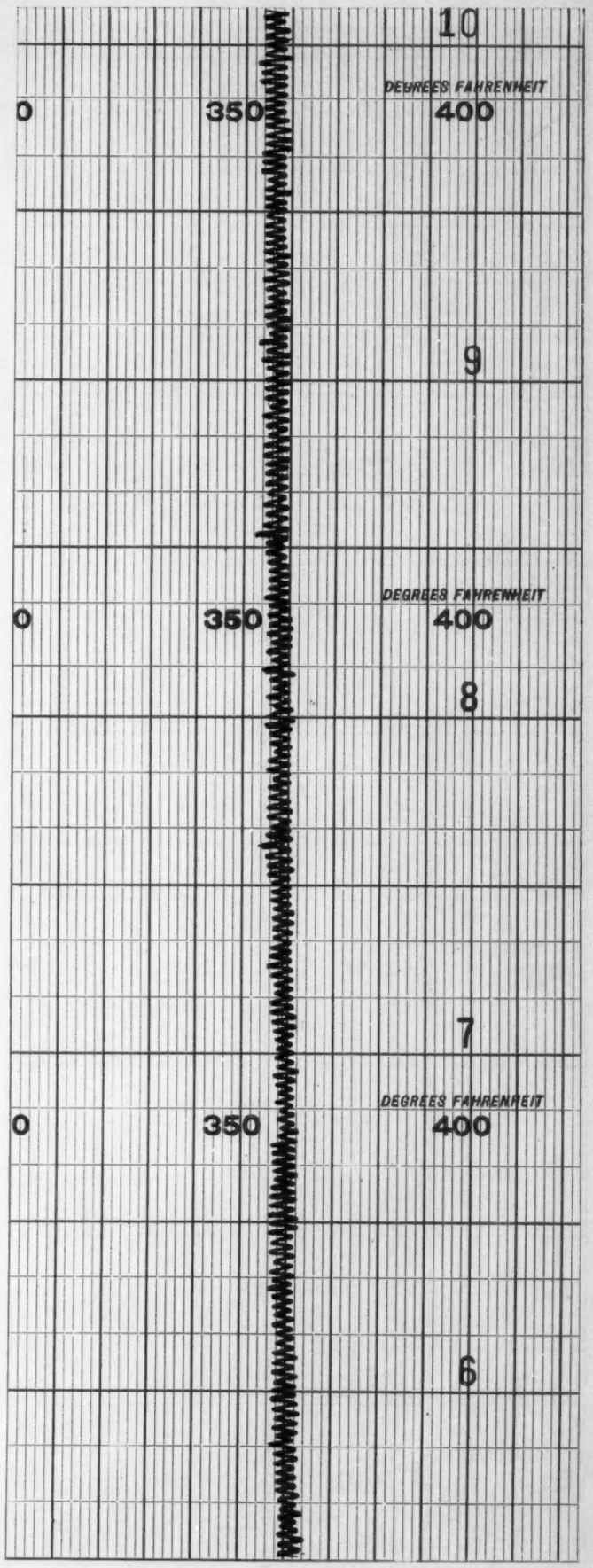


CHART II.
Three-position control on bubble tower.

[1]From M. F. Behar's "Fundamentals of Instrumentation."

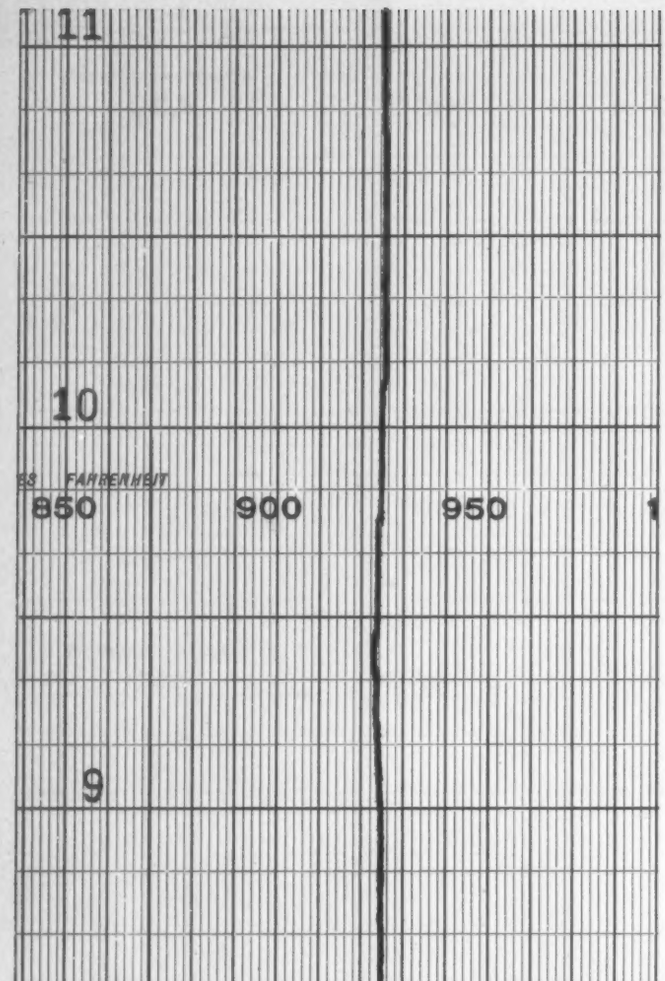


CHART III.

Good hot oil outlet control.

ured. They are a part perhaps of the most flexible system of measurement and control yet developed, are cheap, reliable, easily replaced and checked.

Radiation receivers are also used as primary elements to control furnace temperatures through pyrometers. This system has extreme sensitivity because the radiant energy varies as the fourth power of the absolute temperature. The use of the radiation element for controls is still very limited but apparently has great possibilities for future development.

Resistance thermometers are of remarkable accuracy but are seldom used in refinery temperature control work due to the initial cost, high maintenance and the fact that their more or less complicated nature reduces their reliability.

In making a choice of a primary element it would be well to make such a selection only after a comparison of the following characteristics: time lag, ease and cost of replacement, overall sensitivity, temperature compensation and ease of checking.

One of the worst enemies of successful control is time lag. This lag is the time that elapses between the deviation of the controlled temperature from the control point and the first effect on that temperature of the corrective action of the control. It is divided into two distinct parts; first the process lag and second the instrument lag. The former can be reduced by proper location of the primary element, the latter by proper selection and installation of the primary element and control instrument. Time lag is a very important point to consider in furnace controls as these must act with as little delay as possible. This is in part due to the fact that there is already a process lag, consequently the lag due to the controlling devices must be minimized as much as possible. It is a self-evident fact that primary elements of small mass will have a smaller lag than larger ones. In the case of a thermocouple it is grounded against the bottom of the well so that the mass that must be heated or cooled in order to produce a response in the controlling instrument is only the end of the well and the tiny thermocouple tip. In the case of a thermometer the well, the bulb and the contents of the bulb, a very considerable mass, must all attain the new temperature in order for the instrument to correctly indicate the change.

A primary element may be of the type that will operate successfully yet its use may be curtailed due to the fact that whenever a replacement is necessary for causes such as fires, damages, or failures, the procedure is either costly or requires excessive time to remove and repair. Under modern still operation it is essential that all such elements be replaced easily, rapidly and at a reasonable cost. They should also be such that repairs can be made by the maintenance men otherwise sufficient additional elements must be

stocked that the damaged elements can be sent to the factory for repairs.

The overall sensitivity of a control means the temperature change necessary to initiate a corrective action of the control. This is a function of the type of primary element and the sensitivity of the instrument. In modern practice this requirement is becoming more and more exacting while instrument makers on their part are producing controls so sensitive that they are guaranteed to control furnace temperatures within a range of 1°F±. This means that a deviation of a fraction of a degree from the control point will initiate a corrective action.

Every instrument is affected to a greater or less degree by changes in the atmospheric temperature and must be compensated for such changes. Temperature compensation is now a lesser consideration than formerly because of the great improvements in the design of the temperature measurement devices. It is now more a question of how often the compensation must be balanced in those cases where manual adjustment is necessary.

In making a comparison of elements the ease with which checks may or may not be made is often lost sight of. It is essential that the correctness of the element be easily determined by comparison with a satisfactory standard. This must be done with a minimum of interruption and without upsetting of the control. As this is a procedure called for very often by the operating staff it is essential that such can be done quickly, accurately and without undue fatigue to the maintenance man.

The controls themselves, and by controls is meant the controllers, controlled valves and mechanisms, cover a very wide range of types and application. They vary from very simple devices to the more complicated ones for handling those difficult conditions where the controls approach the activities of human operators in that they anticipate to a certain extent changes that are taking place in the process.

The majority of the controls use either compressed air or electric power as the transmitting medium between the controller and the controlled valve. Compressed air has been used with remarkable success for some time. Its great advantage is its flexibility. Electric controls are also widely used with the advantage of power to overcome a sticking valve.

The simplest controls are the two position or so called "on-and-off" controls. The valves may be actuated by electric solenoid, electric motor, air or hydraulic pressure. They are classified as two position because the valve can assume only two definite positions, "open" and "closed". This does not mean that the valves are necessarily entirely open or closed, but simply indicates the relation of the two positions. With such controls there is a continuous hunting or cycling of the temperature resulting in a saw tooth

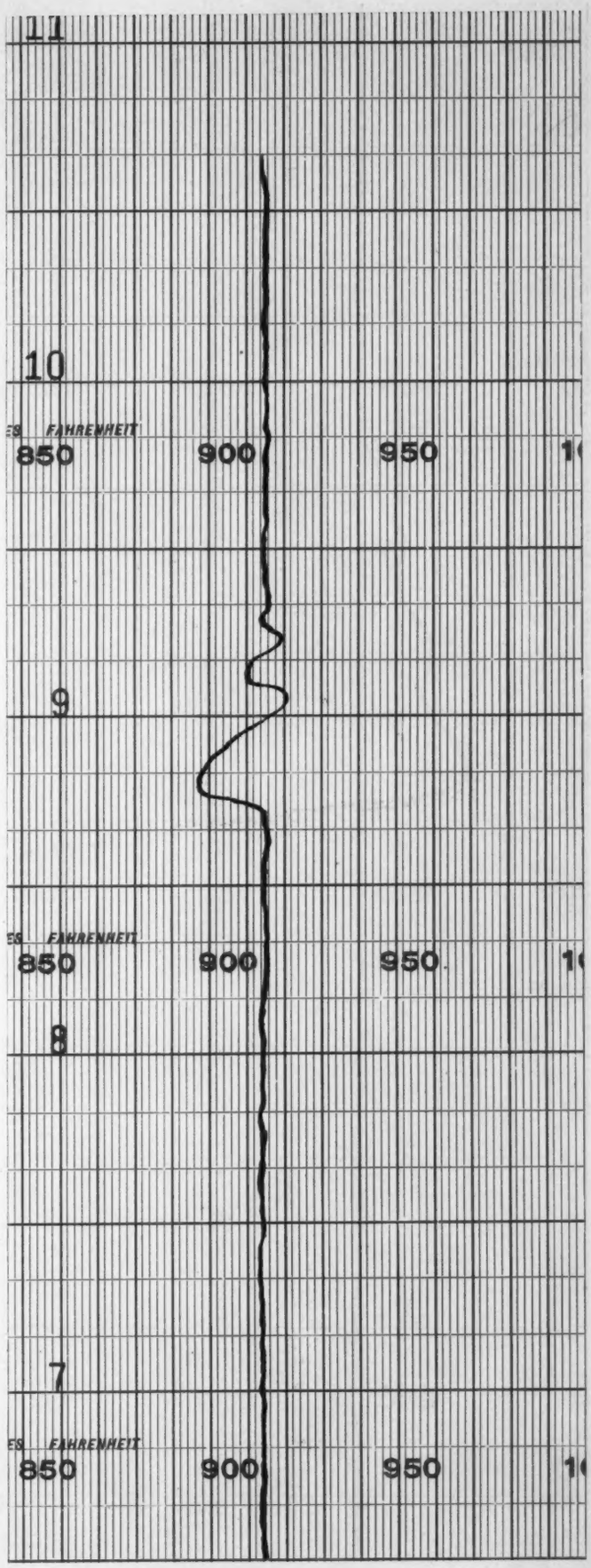


CHART IV.

Hot oil control. Underanticipation.

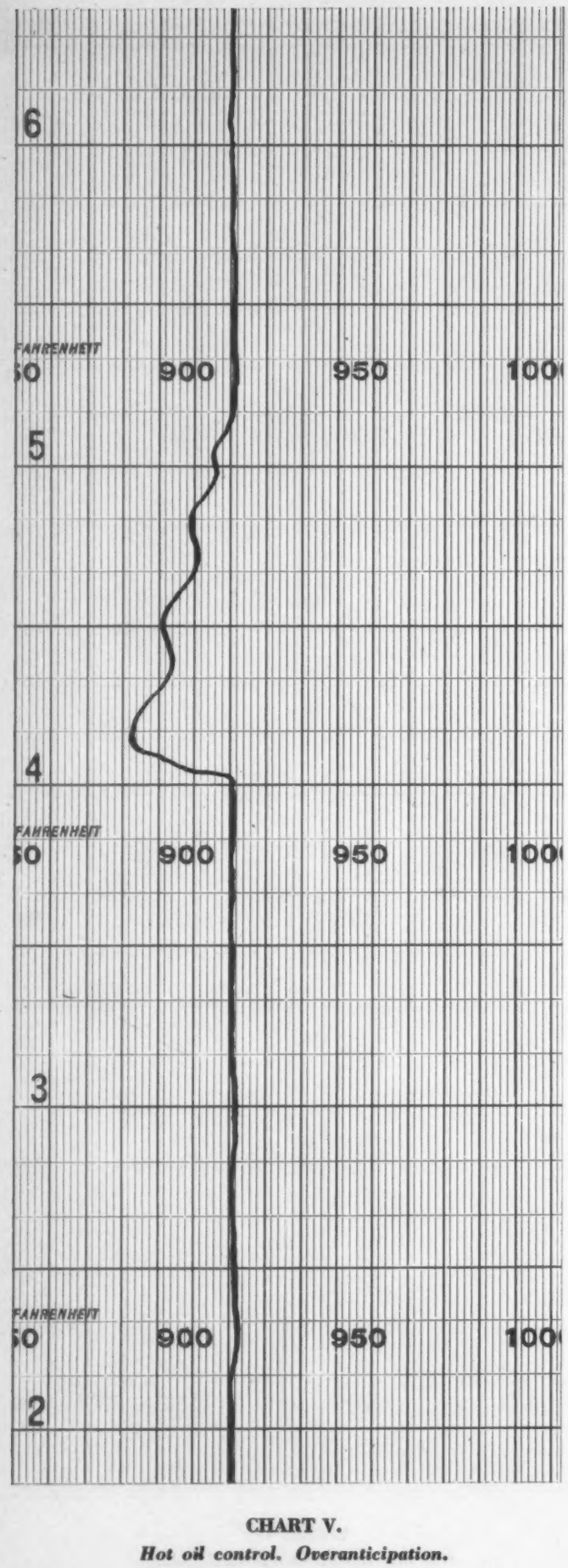


CHART V.

Hot oil control. Overanticipation.

record line. There are many applications where a close control is not necessary and where cycling is permissible. (Chart I) Two position controls are frequently used on bubble towers but are being replaced by more refined controls capable of holding the temperatures to smaller variations.

A recent improvement has been made in pyrometer two position controls. In this system a slight counter or addition e.m.f. is impressed on the thermocouple circuit just before the control point is reached. Thus the control will function sooner than normally, reducing the effect of time lag and decreasing the temperature swing. The only disadvantage of this method is that the temperature record of the controller is distorted and another instrument is necessary for a true temperature record.

A further refinement is the three position electric control which is really a modified two position (Chart II). This control has a middle position which is the normal operating point for the control. A change in temperature causes the control to work either side of the center position. For example with the valve open fully the temperature begins to increase sufficiently to actuate the control. The control then returns to the central position. Should this be sufficient it will remain there. However, should the temperature still continue to climb after a definite time interval the control will make the next step of fully closing, remaining thus until the temperature has fallen enough to again cause it to return to the central or normal position.

The next classification in controls brings in the simple "throttling" or "floating" type. It includes air actuated and electric one or two motor valve mechanisms. This class has the advantage over two and three position types that the valve has no definite position with respect to the control point, but can "float" over its entire range. Air actuated controls in this division have the handicap that for a given deviation of the temperature from the control point there is a definite opening or closing of the pilot valve. This relation is not changed automatically with change in heat demand but must be adjusted manually.

Single motor electric floating controls are designed so that the valve is moved in small increments. The amount of the correction is proportional to the deviation from the control point and is repeated until the temperature returns to the control point. The weakness of this system is the fact that a strong initial effort cannot be obtained. As a consequence the two motor type has been developed.

In this control a change of temperature causes the initial stroke motor to make a very positive change in the position of the control valve. The balancing motor then continues to move the valve in the same direction in smaller increments until the change in

temperature has been arrested. Thus the second motor enables the mechanism lever arm to take any position throughout its entire range of movement to correspond to the middle or normal position of the initial stroke motor. Where operating conditions require a wide range in valve movement and where the three position strong initial movements of the valve are not objectional this mechanism is very successful. Where there is a moderate process lag an arrangement can be added so that the balancing motor will not move the control valve until the process has had a chance to respond to the movement made by the initial stroke motor.

Floating or throttling controls will hunt on any application where there is appreciable time lag because they are always correcting for a condition that used to exist. They make practically no allowance for time lag and do not take into consideration the rate of departure of the temperature from the control point.

Process time lag cannot be eliminated. Therefore instrument manufacturers have developed controls that will give smooth control in spite of time lag. Various electric and pressure operated controls are available and each has its particularly worthy points but they all accomplish the same purpose of anticipating what the temperature is going to do. In other words they correct for what is going to happen instead for what has happened. The temperature controlled by such an instrument deviates from the control point. The controller actually makes an analysis of the rate and direction of the deviation and makes the required correction. If this correction be insufficient it makes another. This process of analysis and correction continues until the temperature starts back toward the control point. A too rapid return would result in overshooting the mark so the control anticipates this possibility and makes corrections to partially offset the original ones. Thus the temperature is not allowed to change too rapidly in either direction and is truly under control. In some types of this class every correction is attended by a smaller counter correction that is delayed to conform with the time lag of the installation. This method is not as correct theoretically as the one first described but it works out satisfactorily in actual practice.

In this kind of air control the standard spring loaded diaphragm valve is generally used. One manufacturer uses a regulator type valve with pressure on both sides of the diaphragm to avoid the possibility of spring failure or fatigue causing the valve to stick. Another manufacturer uses a type of valve in which any sticking results in additional changes in air pressure until the valve does move.

For electric control both single and double motor mechanisms are used. The two motor type is gener-

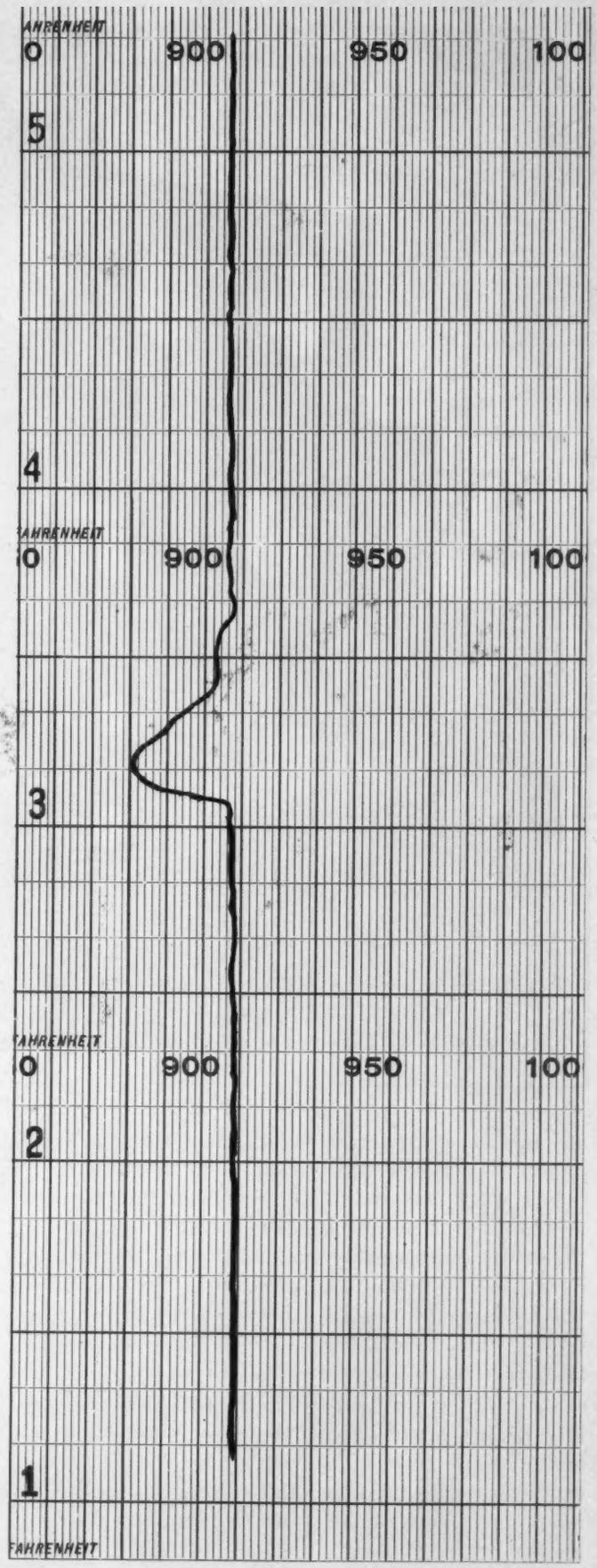
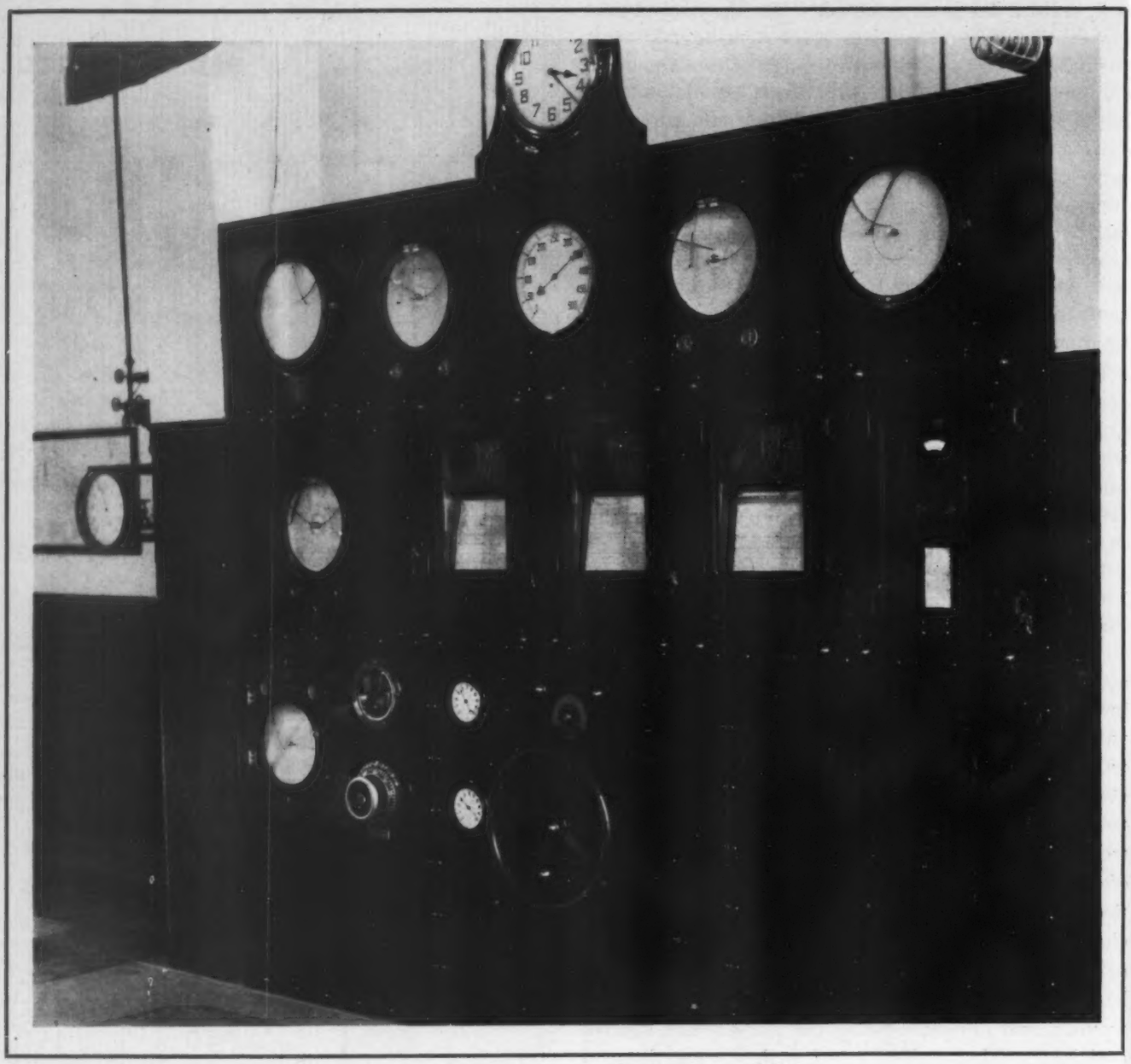


CHART VI.

Hot oil control. Correct control.



ally the more satisfactory as it is the more easily adjusted to a specific installation.

It is very essential that controls in this class be provided with sufficient accessible adjustments so that they can be readily adapted to meet the requirements of the individual application. Such controls will improve the control where any of the others is now used and can be used successfully on applications that the others cannot handle at all.

Relatively recent and still in the development stage are the hot oil furnace controls for controlling the outlet temperature of the oil. (Chart III). Several types have been marketed and although successful in many cases their application has not yet become general.

The location of the primary element is the first and one of the most difficult problems in controlling outlet temperatures. If we simply place a thermocouple just above the bridge wall in the furnace proper and use this to govern the fuel supply our control will hold a constant furnace temperature but not necessarily a constant outlet temperature. Changes in charging rate or inlet temperature will upset the relation between the two temperatures and the control setting must be changed.

If the primary element be located in the oil outlet itself, the process lag will be so great that satisfactory control is out of the question. In order to care for changes in charging rate it is obvious that the primary element should be in the hot oil itself. For this reason the element is usually placed in the roof or radiant tube bank just in front of the bridge wall where the time lag will be the shortest that is feasible. The location of the proper point is largely a matter of cut-and-try as furnace designs differ and a point must be found where the temperature difference between it and the outlet

temperature remains very constant. Experience has shown that tampering with the draft in the furnace may upset this temperature differential.

Another solution to this problem is the use of two primary elements, one in the hot oil and one in the furnace. It will be discussed later because it brings in several additional factors.

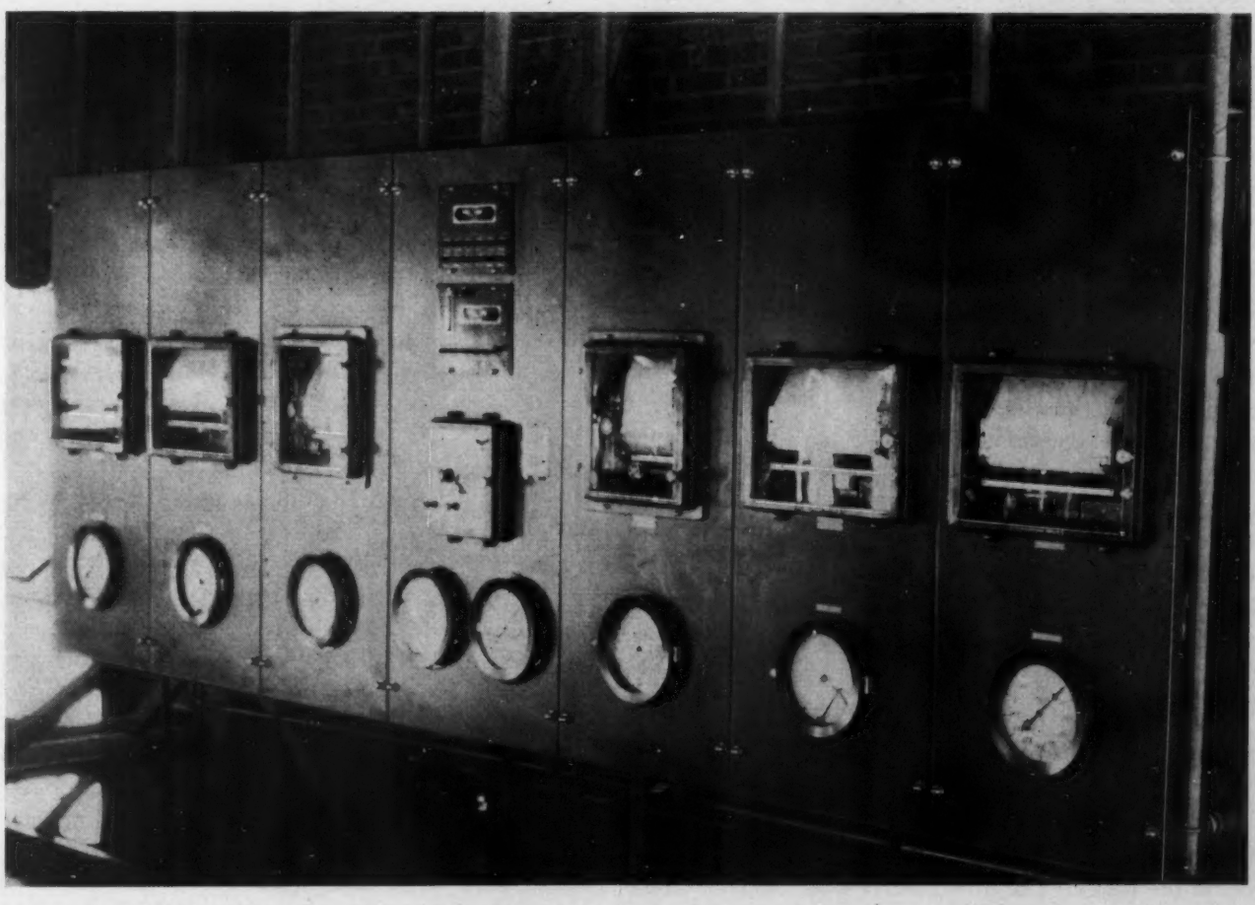
A hot oil furnace control must accomplish much under unfavorable conditions as its operation must correct for the following factors:

1. Fuel pressure variation.
2. Fuel quality variation.
3. Atmospheric, temperature and humidity changes which affect condition of air for combustion and also affects external firebox radiation.
4. Flow variations in oil charged to still.
5. Temperature variations in oil charged to still.
6. Coil outlet pressure changes.

The first of these variable factors can be handled in either of two ways. The most satisfactory method is to use an air-operated diaphragm valve of the regulator type, with air pressure on one side of the diaphragm and the fuel gas pressure on the other side. Thus a change in fuel gas pressure automatically repositions the valve without the aid of the operating instrument. In addition the regulator type construction of the valve eliminates stuffing boxes, greatly reduces sticking and does away with the necessity of loading the diaphragm with a spring for motion in one direction. The second means of handling pressure variations is to have a compensating device in the instrument that will initiate proper corrections in case of pressure variations. Theoretically a good pressure regulator in the fuel line renders further regulation superfluous, however, experience using refinery gas has shown that this pressure anticipation is of considerable value.

Fluctuations in the B.t.u. content of fuel oil are seldom sudden or of great magnitude and further the use of gas as a fuel has practically done away with fuel oil on large stills. However, in the case of a refinery using refinery gas or mixture of refinery and natural gases the variations are often sudden and large. At present there is no successful method in general use for anticipating the upsets that occur in oil temperatures from this cause, the controls simply correcting to meet the new conditions after they have happened. Doubtless in the future the larger plants will hold the B.t.u. content of the fuel gas at a desired figure by the use of a controller that will mix the rich and lean gases in the correct proportions. Small communities have already adopted similar equipment to proportion bottled butane and air for local independent municipal gas systems.

The balance of the factors cannot be or have not been anticipated in the instrument and must be handled after they have taken effect. To be sure, the oil charge



may and should be handled by an automatic flow control, but changes in tower levels frequently require changes in the flow rate and the temperature control must take care of this change by an adjustment of the fuel supply. Due to the inherent instrument and process time lags, the control must be almost human in the respect that when a correction is made the instrument must wait to see the effect and then make further corrections. This correction must then be supplemented by an anticipatory adjustment. That is, the instrument must recognize the trend of the temperature and "head it off" before it gathers sufficient momentum to overshoot the control point.

Hot oil temperature control must be very close because very often the temperature is but a few degrees below the point at which heavy coke deposits form. If a control allows the temperature to rise too high for any length of time the coke accumulation in the tubes may cause local overheating and a split tube or may raise the inlet pressure to a dangerous point necessitating shutting down the unit. Consequently when the temperature of the oil begins to deviate from the control point it is essential that an immediate strong initial stroke or effort be made. Generally this initial effort if allowed to continue is more than enough to bring the temperature back to its original value. Therefore when the temperature trend starts back toward the control point, the initial effort must be partially offset in order to prevent overshooting. The rapidity and degree of this offset should be adjustable so that the total time lag of the installation will be properly anticipated. Underanticipation of this lag leads to hunting (Chart IV.) That is the temperature will swing rapidly from one side of the control point to the other. Overanticipation retards the return of the temperature to the control point and results in a slow weaving of the temperature record. (Chart V.)

The problem of controlling the oil outlet temperature of a furnace has recently been given an interesting and practical solution in the form of an interlocking of the major factors. This plan is theoretically the most sound one yet presented and when developed and simplified will doubtless be extensively used. Let us assume a setup in which the oil charged to a still comes from the bottom of a tower or tank. A flow control governs the rate at which the oil is withdrawn from the tower and is charged to the still. The temperature of the furnace is controlled by a valve in the fuel line governed by thermocouples in the furnace proper. Another thermocouple located in the hot oil outlet operates a control that modifies the action of the furnace control. Also the flow control is tied in with the furnace control and modifies its action. The controls are all electric and are tied in with a series of relays.

To illustrate this control let us suppose that the level in the tower begins to fall. The rate on the flow control will be set down manually to prevent the loss of the level in the tower. The flow control will bring the flow to the new lower rate and simultaneously will reduce the amount of fuel to the furnace in anticipation of the decreased heat demand due to the reduced rate of charge. Thus a certain upset in the outlet temperature is corrected for, long before its effect could show up on the outlet temperature record. Similarly, if the B.t.u. value of the fuel were to change the furnace temperature would rise but the thermocouples in the furnace would pick up this change and correct it ebfore it was felt at the outlet. The theory of this interlocking control is sound because it anticipates certainties and not just what might happen.

Due to the large number and complicated design of temperature controls on the market it is difficult for the man without specific experience in this type of control to select the equipment best suited for his application. We believe that a careful comparison of available controls with consideration of the following factors will go far to simplify the task of getting the instrument that is most adaptable to the specific control problem:

1. Initial cost.
2. Sensitivity of the primary element.
3. Cost of replacement of primary element in case of fire, damage or failure.
4. Ease of replacement of primary element.
5. Recording or non-recording instrument.
6. Atmospheric temperature compensation.
7. Anticipating features and adjustments.
8. Ease of checking temperature.

Practically every temperature that is worth controlling should be recorded. This should be done for the protection of the operator as otherwise he may be blamed even though innocent of any error of control. The record is of value to the engineering staff as it shows any deviations and their extent from normal. To the maintenance man it shows that the control is either in good order or tells his experienced eye its symptoms of disorder. Its most useful function is guiding the operator during those periods which occur occasionally whenever the control is not functioning.

The initial cost of a control installation is something upon which there is always a great difference of opinion. Those who do the purchasing often fail to understand the value of controls and cannot discern any difference in their merits but are guided solely by price. The price tag is only one item in the value of a control. A cheaply priced control may be very dear and a costly one of greater value due to its ability to do better work. Of course it is at once apparent that one should not invest in an expensive control where refinement in control is not necessary. However before a control is purchased a thorough study of it and its application to the process it is to serve should be made. Only after various controls are found that are satisfactory should price comparisons be made. And into that comparison should go the various savings that can be obtained, together with kind and quantity of instruments and mechanisms which constitute the complete control.

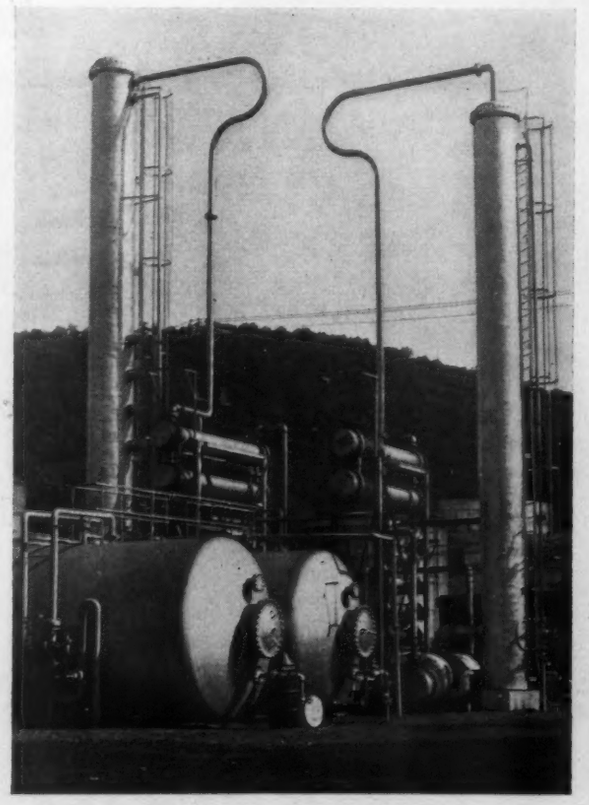
Gas Engine Powered Pumps *Success in* New Pennzoil Plant

GEORGE REID
Associate Editor

ORIGINALLY designed and operated as a reforming unit, the newest Pennzoil cracking installation at Oil City, Pennsylvania, recently has been modified through installation of a hot oil pump and hot oil circulating system. This additional equipment was added to secure greater flexibility, to permit better operation on heavier distillates, cracking with the reforming furnace, and to secure an increase in capacity.

The installation has some novel features. It requires no steam in its operation since all cracking unit pumps are gas engine driven, using refinery gas as fuel, and using a hot stream of oil as heating medium in the stabilizer reboiler. The Pennzoil Company has pioneered in this country in the use of gas engines as prime movers for refinery pumps and this is the second unit at this plant to be so equipped. The unit employs one of the new double compartment, or duplex type of furnaces, in which each section is subject to independent control. There is no soaking or reaction chamber included in the design of this system. It was designed and constructed by Arthur G. McKee and Company, in collaboration with L. D. Fulton, manager of Pennzoil refineries and his staff, and is licensed under Universal Oil Products Company patents.

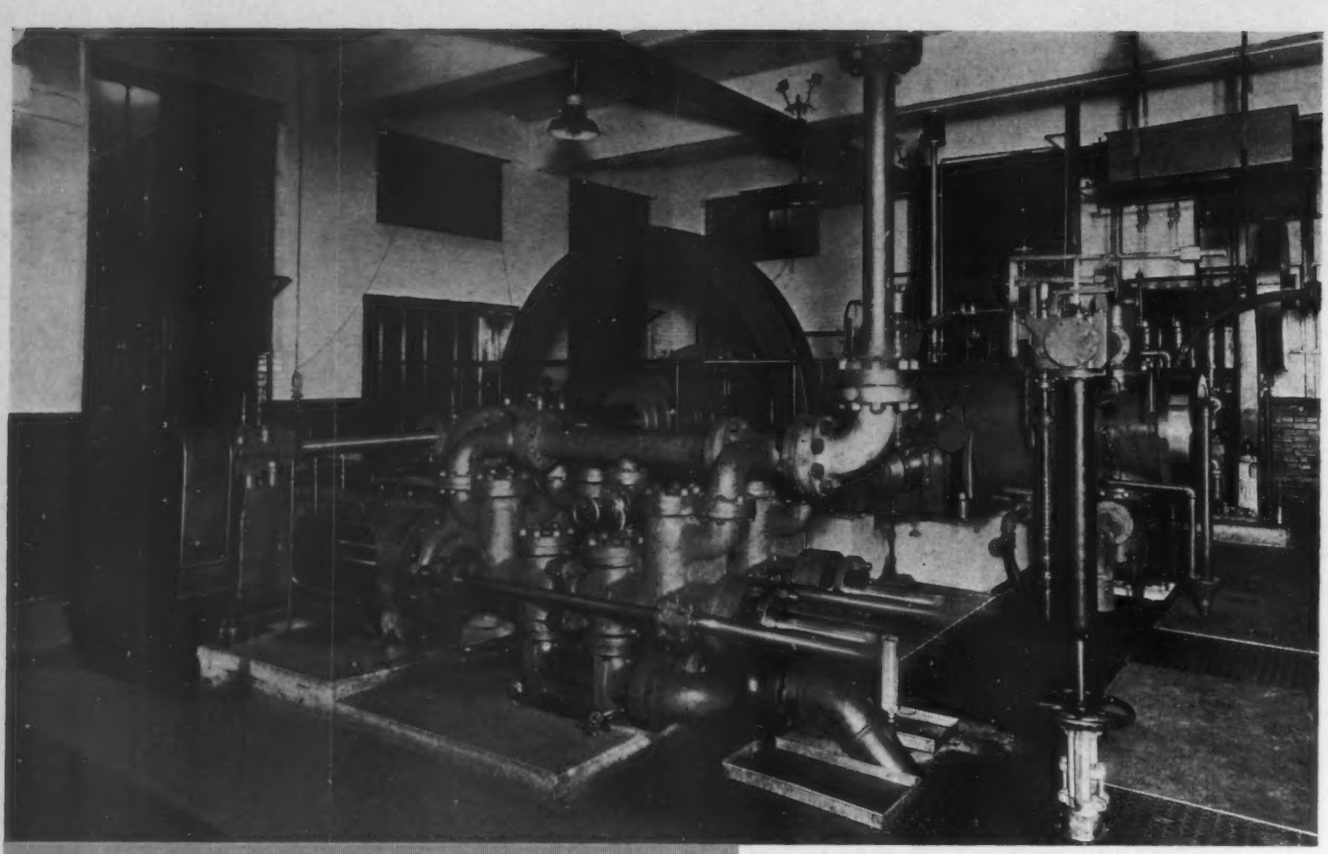
Inasmuch as the unit may be used to reform naphtha, to crack kerosene, gas oil, or mixtures of the two in various proportions, the pressures and temperatures of operation are subject to a variety of changes. Such pressures and temperatures as reported in this description are based on operations in which a 36/37 gravity mixture of kerosene distillate and fuel oil was the charging stock. Residuum was 16/18 gravity, quenching oil 30/31 gravity, raw oil 17/18 gravity, and recirculated stock was 17.5 gravity. The unit was producing 61.5 gravity gasoline with vapor pressure of 11 pounds Reid, with about 75 percent conversion, when operating for 74 octane number. With the hot oil pump in service the charge is around 1700 barrels of fresh oil and 1700 barrels of recirculated oil per day.



Stabilizing system operating in conjunction with the cracking unit.

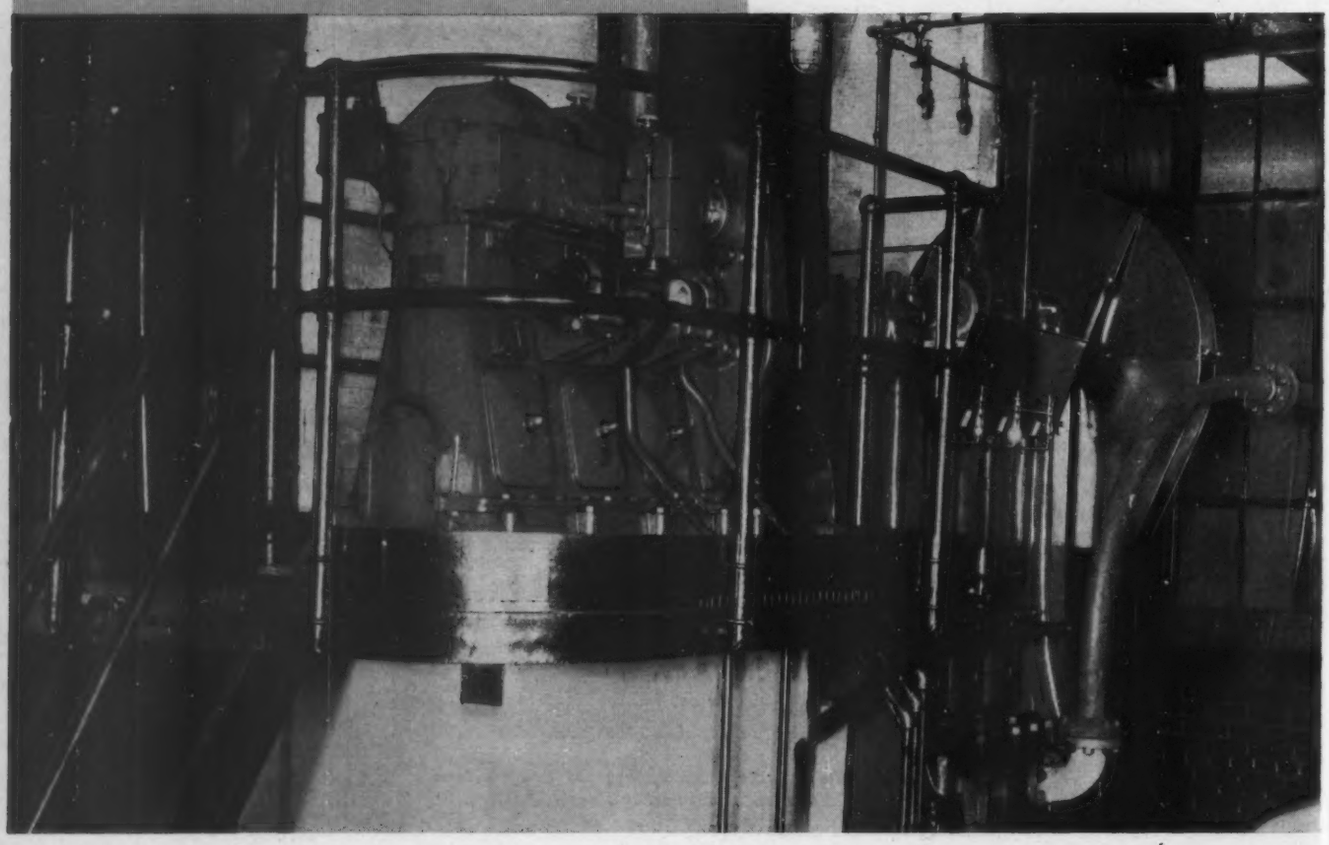
GAS ENGINE DRIVEN PUMPS

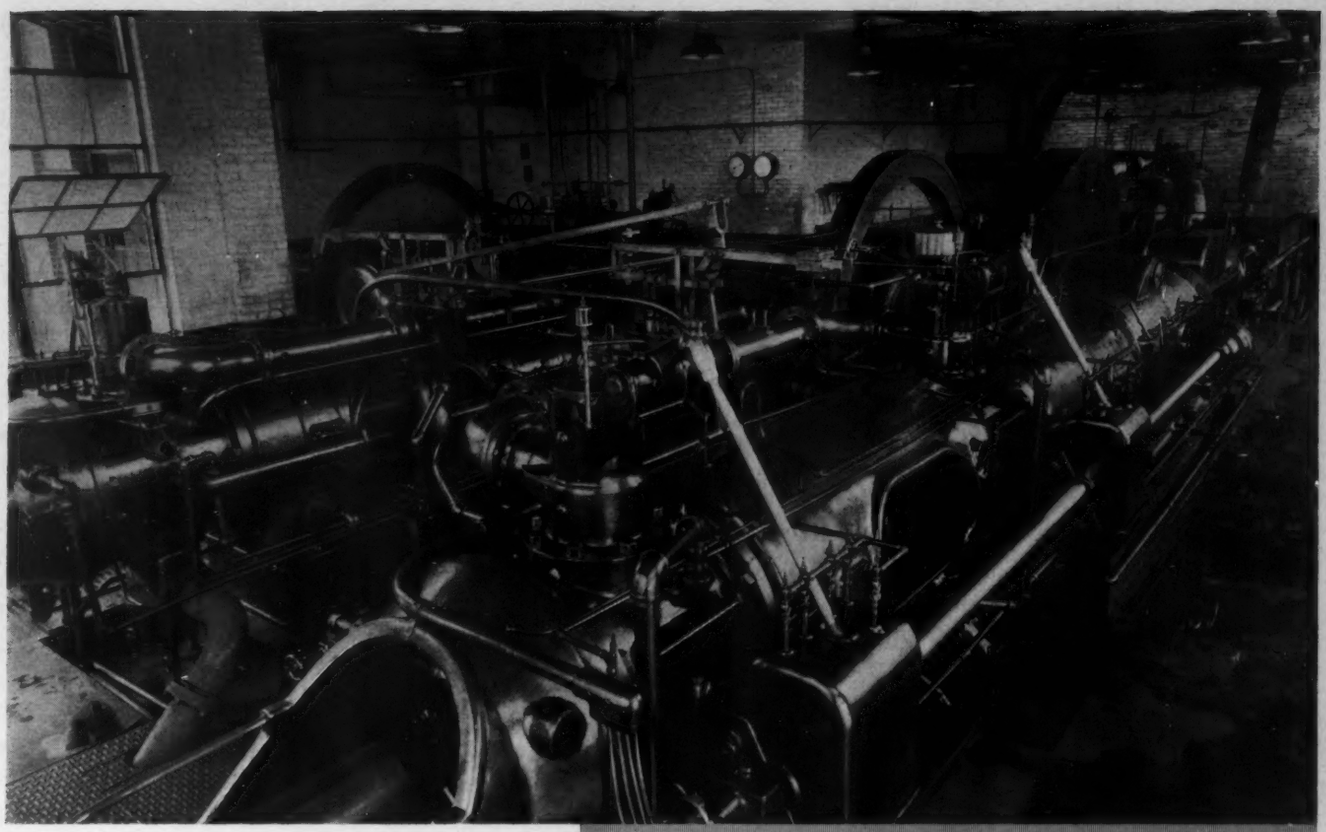
The company's experience with gas engine driven pumps for cracking operations has been so satisfactory that no stand-by pumping equipment is provided. Only four pumps are employed in the operation of the unit proper. The charging pump is a four by 12 inch horizontal, duplex power pump driven by a 90 horsepower 17 x 24-inch horizontal single acting, four-cycle gas engine. The pump handling quenching oil is a 4½ by eight inch vertical triplex power pump driven by a 40 horsepower, three cylinder, vertical gas engine. The recently installed hot oil pump is a 3½ by 12-inch power pump driven by a six cylinder vertical gas engine. All of these pumps and their gas engines were manufactured by National Transit Pump & Machine Company. Reflux is pumped over the fractionating column by a three-inch National Transit rotary pump driven by a seven horsepower General Electric explosion proof motor. The pumps used in connection with the stabilization system are Goulds centrifugals driven by Louis Allis ex-



Cracking unit charging pump is a horizontal duplex power pump driven by a 90 horsepower horizontal single acting four cycle gas engine.

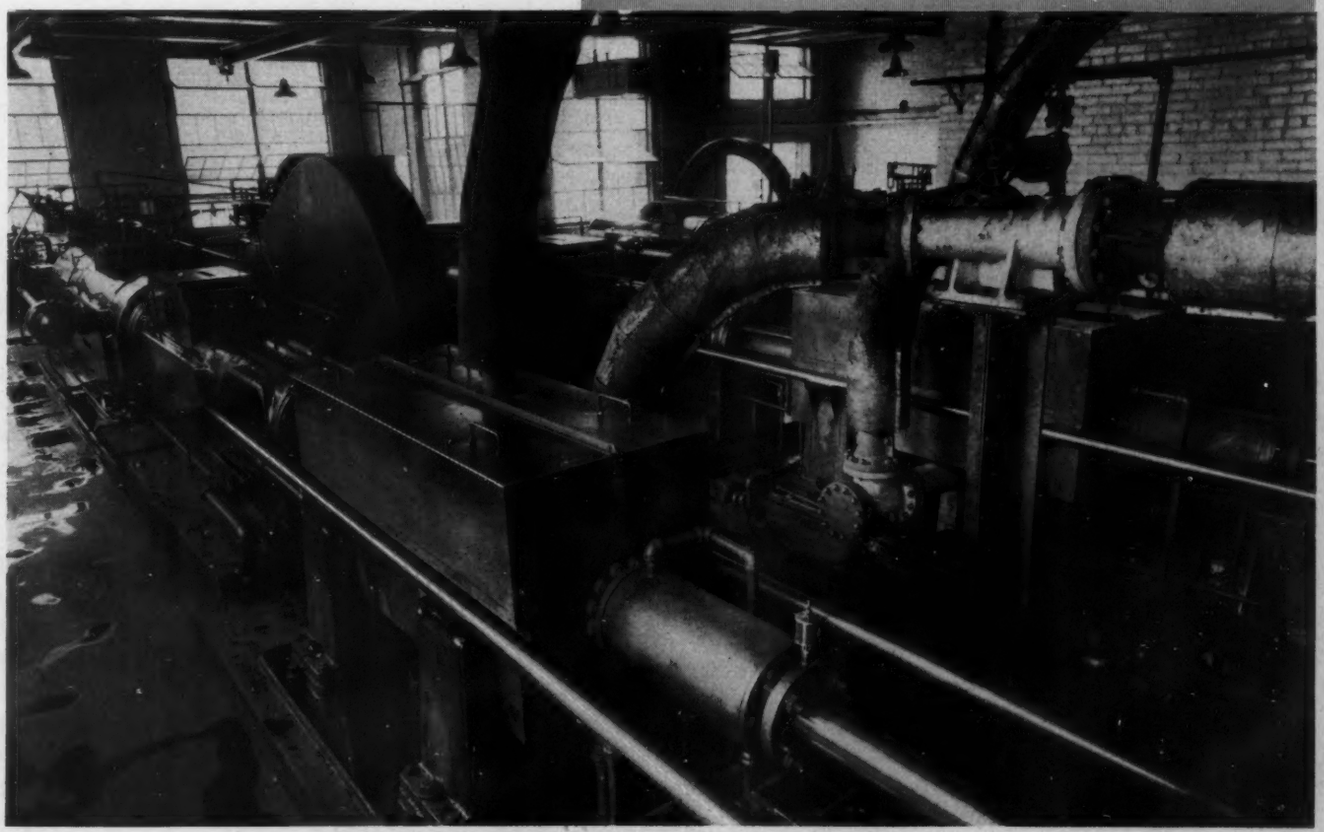
Three cylinder vertical gas engine driving triplex quench oil pump.





Twin tandem gas engine driving duplex hot oil pump on Dubbs cracking plant for The Pennzoil Company, Oil City, Pennsylvania.

Gas engine driven hot oil pump, with water cooled stuffing boxes, plungers, and cylinder supports.



plosion proof motors. Since gas engines consuming refinery gas as fuel and electric motors are used for all pumping purposes, the only steam consumption necessary is that small quantity needed for atomizing fuel oil in the National Air-oil burners when getting the unit on stream, and steam used in the tubes during blow-downs. This condition eliminated the necessity of enlarging the refinery's steam generating power plant and effected considerable saving.

Charge coming to the unit is first preheated in a Ross high pressure vapor-preheater-condenser section set above the main condenser box, and at this point picks up heat from the vapors leaving the top of the fractionating column. The next step carries the charge through two Griscom-Russell Tubeflo type pre-heater-exchangers arranged for palallel flow. Under one set of operating conditions the oil at the tube still outlet is heated to 925°F. and before entering the Tubeflo exchangers is quenched to about 860°F. and at this temperature the heated charge will preheat the incoming oil to about 325°F. in the exchangers. This preheated charge is further raised in temperature when it is mixed with the hot oil from the discharge side of the hot oil pump, and the combined feed enters the convection bank of furnace tubes at about 450°F. The operating pressures under these conditions were raw oil pump discharge, 720/730 pounds; quenching pump, 680 pounds; tube still outlet 600 pounds.

The furnace is divided into two sections, called the heating section and the soaking section, and each section is separately fired, so that independent control of each section may be provided. A convection bank, a radiant bank and a soaking bank of tubes is provided, with no floor tubes. The convection section or tube bank is placed between two air cooled bridge walls in the center of the furnace. The hot gases of combustion are deflected by these to bridge walls so that they sweep the convection tube bank as they leave the furnace. There are 48 carbon steel tubes in this convection bank, 30 feet in length. In one end of the furnace is the heating section, consisting of 43 tubes, and with tubes at the side walls and only one row of roof tubes. In the other end of the furnace is the soaking bank of tubes, 63 in number, with a double row of tubes in the roof and a single row on the wall. All of the radiant section tubes are 3½-inch i.d. with ⅝-inch walls, 30 feet long, and contain one half percent molybdenum. The carbon steel tubes in the convection bank are 3½-inch i.d. with ½-inch walls. Ohio Lock return bends were used, of cast steel and containing one half percent molybdenum. In the absence of corrosive conditions, chromium and nickel were not thought necessary for these tubes, but the molybdenum was added to secure high creep strength at high temperatures.

Oil entering the furnace passes first through the convection tube bank, then through the heating section in one end of the furnace, and finally through the soaking section in the other end. The furnace is fired at about 1365°F. in the heating section and around 1170°F. on the soaking side. Oil leaves the convection section or bank at 657°F., passing from wall to roof tubes at 775°F. and goes into the soaking series of tubes at about 925°F. where firing is maintained to hold this temperature constant. The vapors leave the furnace at 600 pounds pressure, are quenched as previously described, pass through the high pressure preheater-exchangers and into the flash chamber in the bottom of the tower.

FLASH AND BUBBLE TOWER

The combination flash and bubble tower has the flash section, eight by 16 feet, at the bottom, an umbrella type baffling is above this, and the fractionating section, with 14 bubble trays constitutes the upper section. A De Florez remote control valve, operated from the control board, maintains a pressure of 600 pounds on the outlet of the exchangers, reducing this to about 90/100 pounds, at which pressure the flash chamber and fractionating column is operated. The residuum falls to the bottom of the flash section of the tower. As the vapors rise upward temperature is controlled by refluxing, to the end that at the third bubble tray a heavy side stream is accumulated, and withdrawn into a vessel termed the quenching oil drum. The remaining vapors pass upward and out of the tower, through the vapor-heat exchangers, through the condenser box, filled with Griscom-Russell Bentube sections, and to a large receiver tank.

The quenching oil drum is maintained under operating pressure of 90/100 pounds, which is sufficient to force a stream of this oil through the stabilizer reboilers. Heat for operating the stabilizer is extracted from the quenching oil on the suction side of the quenching oil circulating pump, and this eliminates the necessity for making the quenching oil pump a hot oil pump and of making the heating coil in the stabilizer reboiler of high pressure tubes. Vapor locking does not occur at the pump because the lowering of the temperature of the heating oil more than compensates for the pressure loss from passing through the system. More quenching oil is available than is required by the stabilizer reboiler so the temperature of the reboiler is controlled by means of a by-pass around the heating coil. The quenching oil drum is also the source of suction for the hot oil pump, which discharges into the charging line carrying fresh feed and at a point between the preheating-exchangers and entry into the convection bank of tubes.

The stabilizer used in conjunction with the cracking unit was designed by Pennzoil engineers and built by Struthers-Wells Company. Gasoline accumulating in the cracking unit receiver tank, which also serves as a source of the refluxing liquid used to control fractionating column temperature, is charged to the stabilizing system. Noncondensable gases are released from the receiver by means of an automatic back pressure valve. These gases and those which leave the stabilizer are

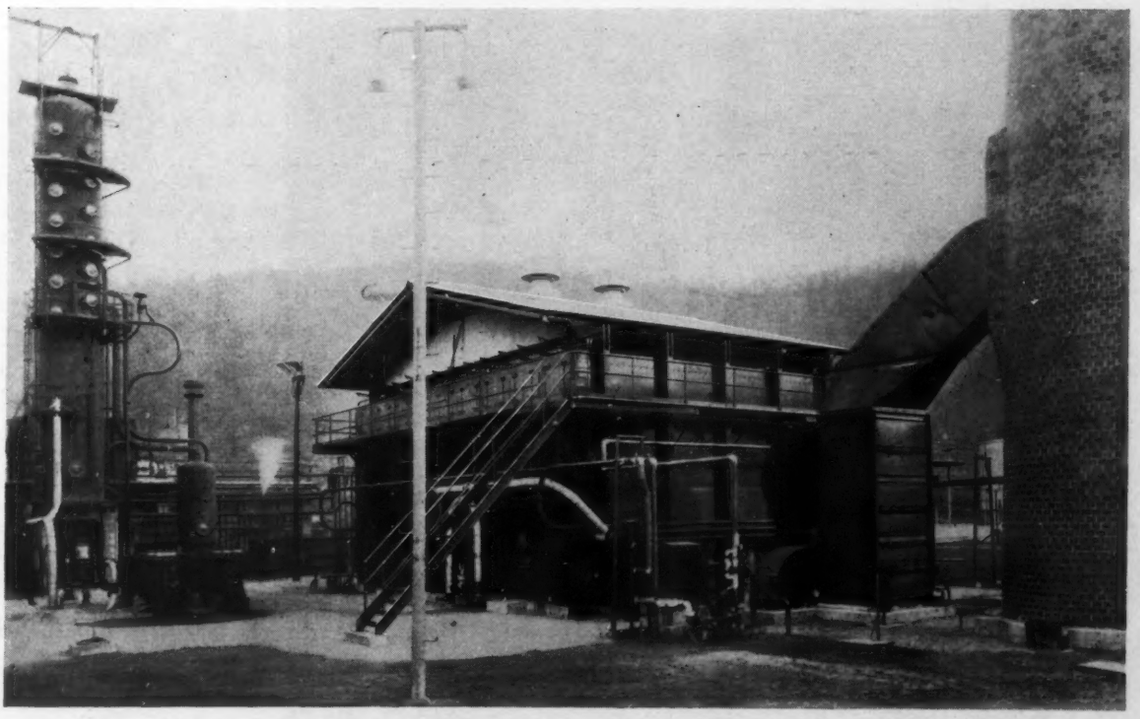
combined, washed with lime solution for removal of H_2S, and used to fire the still and operate the gas engines driving the pumps. The remainder passes to the company's Number 1 plant under its own pressure where it is employed for similar purposes. The stabilizer is operated at 135-150 pounds on the tower and the top tray temperature is held at about 80°F. The reboiler temperature is held at about 300°F. and a normal reflux ratio of 6 to 1 is used. Since the hot oil from the quenching oil drum is used as a heating medium in the reboiler and preheater, and as the pumps are driven by explosion proof electric motors, no steam is required for heat in the operation of the stabilizing plant.

CONTROL EQUIPMENT

Automatic control equipment on the cracking plant consists of one air operated pressure recorder controller with the valve in the gas line leaving the receiver tank; one air operated temperature recorder controller with the valve in the discharge line of the pump refluxing the top of the fractionating tower; and one air operated pressure controller with the valve in a by-pass on the discharge line of the quenching oil pump controlling pressure of the quenching oil. All three of the gas engines are controlled by speed governors included with the installations. The pressure on the high pressure side of the unit is controlled manually by a remote valve mounted on the control board. Absolute control of temperature of either heating or soaking side of the duplex type furnace is made possible by laying a separate gas line to each section through the control house with a globe valve in each line, having the wheel mounted on the control board.

The remainder of the instruments consist of flow meters, indicating and recording potentiometers, indicating and recording pressure gauges, all of which are mounted on the control board so that the operator may handle the unit without leaving the control house.

The Pennzoil Company, since March, 1931, has been thoroughly testing through actual use, the economy and reliability of gas engine driven pumping units, and is the pioneer operator of such equipment in this country, becoming so after checking thoroughly the experience records of Imperial Oil Company of Canada, at Sarnia, where National Transit gas engine driven pumps were installed in 1929. The first unit of this type installed by The Pennzoil Company went into service in the spring of 1931 and was a National Transit horizontal twin tandem single-acting, four-cycle gas engine back geared to a horizontal duplex end packed plunger hot oil pump, which had its fluid end or cylinders of forged steel using water cooled stuffing boxes, water cooled plungers, and Transit patented water cooled cylinder supports. The second unit, installed at the same time, was a gas engine driven charging pump composed of a horizontal single-acting, four-cycle gas engine connected to a horizontal duplex, end packed plunger pump by means of a flexible coupling and single reduction gears. These gas engines using refinery gas, or what might be termed in many refineries a waste product, as fuel, have given every evidence of economy, together with equally reliable performance as steam and electric motor driven pumping units in service elsewhere at the company's refineries.



The Pennzoil Company's newest cracking plant, which was originally installed as a reforming unit. No reaction chamber is used in this system.

Improvements at Marathon *Plant Include* Combination Cracking Unit

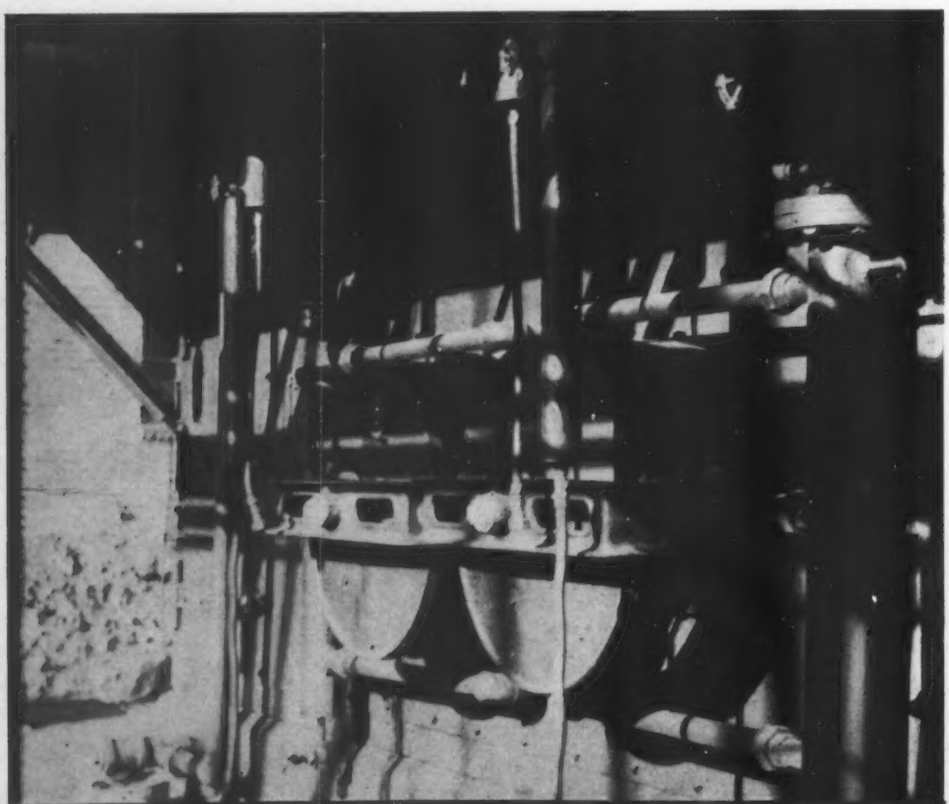
J. C. ALBRIGHT

MARATHON Oil Company, Bristow, Oklahoma, recently revamped its shell still by converting it into a rerun and skimming plant for production of straight-run gasoline, reduced crude and other products. At the same time a combination cracking plant was erected, to which the reduced crude is charged in order that a recovery of high octane gasoline can be secured, as well as a greater yield from the original charging stock.

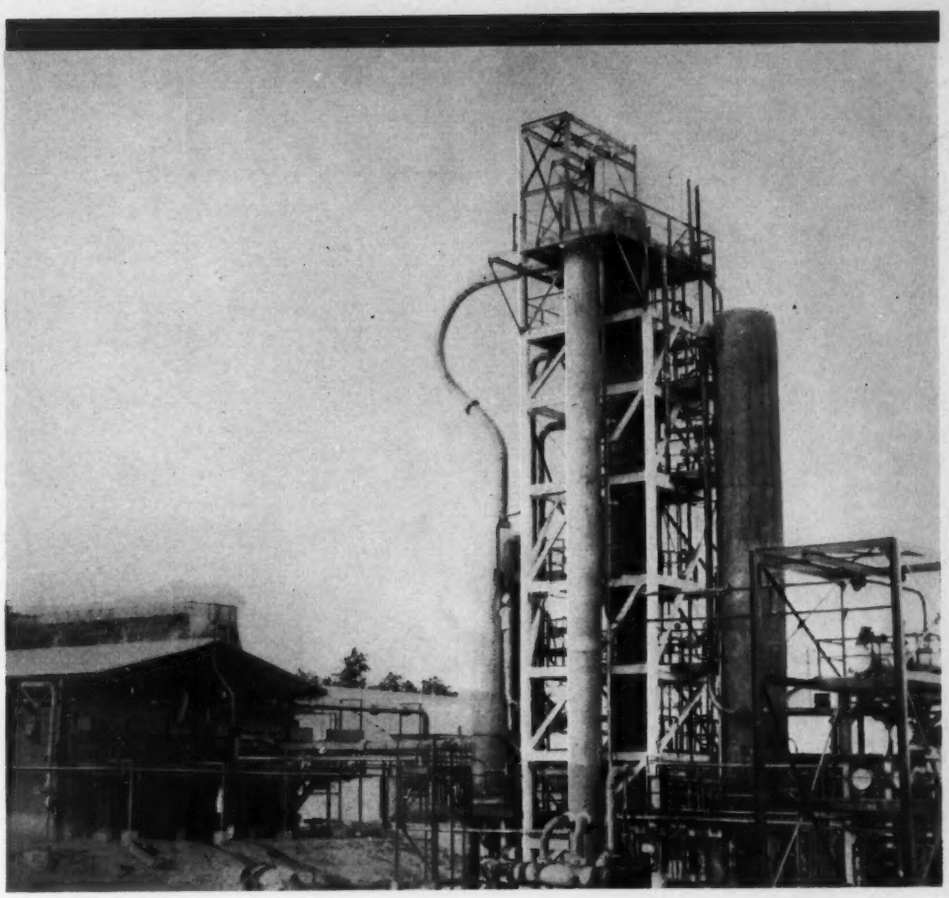
This combination cracking plant was designed and erected by The M. W. Kellogg Company to process reduced crude through a viscosity breaking furnace and cracking in the vapor phase. Capacity of this unit as designed is for 1500 barrels of cold reduced feed stock daily. It is designed to operate on this class of charging material, and when so operated, two products, stabilized high octane motor fuel, and fuel oil, are obtained.

Circulation was begun about the first of June, 1933, and immediately after the necessary adjustments were made, regular runs have been accomplished by charging the residuum from the Bristow crude prepared in the shells of the revamped original battery. This stock, having been stripped of the straight-run gasoline, naphtha, kerosene and other cuts desired, has a gravity of 23° A.P.I. This residuum, or reduced feed stock, is pumped from the shells to either of two 5000-barrel tanks. While one of these tanks is being filled with charging stock for the Kellogg unit, the other one is being drained by the reduced crude charging pumps.

By operating this unit up to the economic capacity, an average of 1750 barrels of this reduced feed stock is picked up cold by a low pressure National Transit steam-driven reciprocating piston pump and discharged through two Kellogg shell and tube exchangers to impart to the charging stream a temperature of 530° F. The exchangers are placed so that this temperature is applied immediately before releasing the charge to the fuel oil flash tower. This column, five feet six inches by 48 feet, receives the stream of hot reduced crude at a point five plates below the top of the tower and under a pressure of nine pounds. Three products are removed



Gas burners as installed firing the viscosity breaker section of the furnace.



Marathon Oil Company's 1500-barrel combination viscosity breaker and vapor phase cracking unit at Bristow, Oklahoma.

from the operation of this column, an overhead cut called "flash distillate"; bottoms as railroad fuel oil, and a cut accumulated midway of the tower which is utilized as a charge for the viscosity breaker furnace.

The charge forming in the accumulator pans in the fuel oil flash tower is picked up under a suction pressure of nine pounds by a National Transit gas engine-driven hot oil pump, 3⅛ by 18 inches and delivered under a discharge pressure of 280 pounds to the viscosity breaker coils in the combination furnace. The volume of this feed averages 3000 barrels per day, and as it leaves the coils through the transfer line under a drop of 10 pounds, the temperature has been raised to 870°F. The material in process is now introduced into the evaporator under a pressure of 250 pounds where the charge is separated in two fractions, the overhead passing through the cold reduced crude exchangers on the fuel oil flash tower, and the other, the bottoms, vented back to the fuel oil flash tower below the viscosity breaker charge accumulator pan.

The bubble tower, the third column in the series, is carried at 245 pounds operating pressure at 740°F. at the flash point, produces two cuts; overhead being fractionated pressure distillate or cracked gasoline, and the bottoms, picked up by another one of the National Transit hot oil pump, is the material charged to the vapor phase cracking furnace. These bottoms picked up at tower pressure are discharged from the hot oil pump under a pressure of 475 pounds, leave the outlet of the vapor-phase cracking tubes at 970°F. and under 270 pounds pressure.

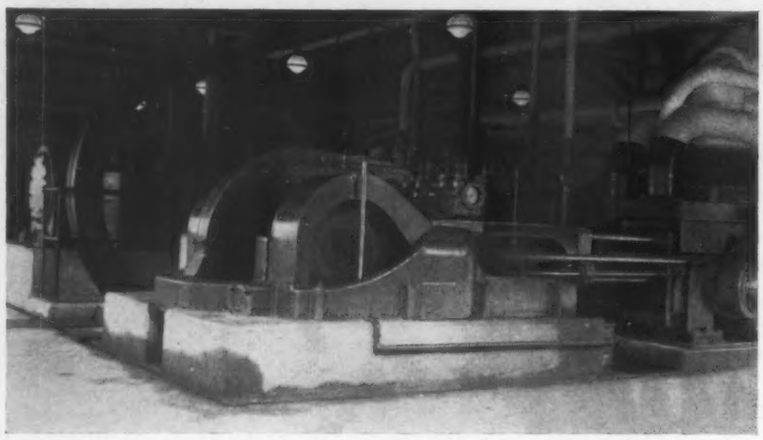
The transfer line through which the cracked charge is carried enters a manifolded piping common to the discharge of the viscosity breaker furnace and the vapor phase coils, and enters the evaporator through the same nozzel. By this method, the heavy tarry residuum from the vapor phase unit is dropped to the bottom of the evaporator to combine with the heavy oils in the viscosity breaker discharge, in order that both may be flashed from 250 pounds at the outlet of the evaporator, to the nine pounds pressure carried in the fuel oil flash tower.

As all the fractions which are desired in the manufacture of high octane gasoline are processed through the various units, they finally leave through an overhead line from the bubble tower at 435°F. Condensed and cooled in Kellogg shell and tube units, the material is accumulated in a drum where the gas, largely fixed vapors, is separated from the gasoline. Picked up at 230 pounds, a part of this condensate is circulated back over the top of the bubble tower to control the overhead temperature and the characteristics of the cut leaving the column.

As the process is continued, this gasoline is picked up by another of the National Transit pumps in the operating battery and delivered to the "finished gasoline to charge" exchanger before it enters the stabilizer column for final fractionation. A Kellogg reboiler is set

at the base of the fractionator column, and the heat that is applied to this unit comes from a stream of hot oil taken from the base of the bubble tower under a temperature of 600°F., providing a temperature of 420°F. to the reboiler unit.

This stream of heating oil passing through and after leaving the reboiler is combined with the flash distillate, the overhead product of the fuel oil flash tower, and used as reflux, or wet trim, over the middle section of the bubble tower, at two points in the evaporator and either in the base of the fuel oil flash tower or over the top section as the case may be, depending upon the operating conditions at the plant, the character of the oil in process and the cuts desired.



Hot oil pump is driven by a 90 horsepower gas engine.

In fractionating the gasoline in the stabilizer column, 340 pounds processing pressure is maintained with an overhead temperature of 135°F. That fraction condensed from the overhead stream is accumulated in a horizontal drum and used as a temperature controlling reflux back over the top of the tower. This condensate consists principally of propane and iso-butane, but some of the normal butane is released in the overhead cut when the vapor pressure of the bottom product is higher than the sales requirements specify. The excess liquid above the reflux requirements is vented to a common line into which the fixed gasses arising from the bubble tower condenser accumulator drum are carried. The combined volume from the two sources, averaging around 500,000 cubic feet daily, is used as fuel in the combustion chambers of both the viscosity breaker and vapor phase cracking furnaces.

The characteristics of the bottom product from the stabilizer column are as follows:

Gravity	61.5°A.P.I.
I.B.P.	93°F.
10%	120
20	150
30	188
40	217
50	250
60	272
70	296
80	328
90	372
E. P.	396
Color	16
Octane	70

To improve the color and in the reduction of the gum content, the product after being stabilized, or debutanized, is treated and afterward rerun through two of the revamped shells of the original battery, to which has been added a modern fractionating column and condensing accessories fabricated by American Tank and Equipment Company.

Two features of this plant are essentially different from the ordinary installation. One consists of the method of driving the hot oil pumps handling the reduced crude to the viscosity breaker furnace and the charge from the base of the bubble tower to the vapor-phase cracking coils. Usually, but not always, this drive is accomplished either by electric motors or steam-driven crank and flywheel cross-compound pumps. A few refineries lately have been equipped with Diesel driven hot oil pumps. In this plant, the installation is composed of National Transit hot oil pumps driven by National Transit four-cycle 90 horsepower horizontal gas engines. One for each hot oil pump and directly connected to the pump reduction gear shaft with Fasts couplings. Material for fuel is taken from the dry natural gas lines within the plant fuel system.

The other feature is the method of providing process steam for the high pressure distillation and fractionating columns. Boilers in the plant were designed to operate at 100 pounds, which was sufficient when built to drive the necessary pumps. All of the process pumps in the new unit are driven by this low pressure steam except the above mentioned gas engine-driven hot oil pumps. To provide high pressure dry steam for introduction into the columns which exceed 100 pounds pressure, water is picked up from exhaust condensers and pumped by means of a Hills-McCanna proportioning unit to a bank of steam generating and superheating coils, 1½ inches in diameter, placed in the bridge walls of the cracking furnaces. Temperature in this section of the cracking system is sufficient that steam may be generated without detracting from the cracking efficiency of the coils.

Levels in the towers at the point of accumulator pans and the bottoms are indicated to the operators by Klingerite reflex gages.

Towers in this plant are insulated with an application of Eagle Picher plastic insulation and the tower supports are fire-proofed. Coen gas burners are installed, six units, three in each end of the combination furnace; four serving the vapor phase cracking coils and two the viscosity breaker.

Simplicity and Compactness *Feature* Oil Creek Tube Still Installation

SIMPLICITY is the principal feature in the design of Oil Creek Refining Company's tube still distillation unit erected early in 1933 at the company's Titusville, Pennsylvania, refinery. Designed with a capacity rating of 1500 barrels, the system fractionates this volume when running to a 650 stock, and processes 2000 barrels when running to a 600 stock. Gasoline is taken overhead from the column, with naphtha, kerosene, gas oil, wax distillate and slop wax removed as side streams; green stock constitutes the bottoms or residue.

Crude is charged at a pump pressure of about 100 pounds, through a series of exchangers. The first of these is a vapor heat exchanger where 145 to 150°F. heat is recovered from the gasoline vapors leaving the top of the fractionating column. From this point the crude passes to a settling drum, then to a second exchanger where additional heat is recovered from the hot gas oil side-stream coming from the tower. The warm crude is then conducted to two bottoms exchangers operating in parallel, receiving a final preheat of 325°F. as it enters the still.

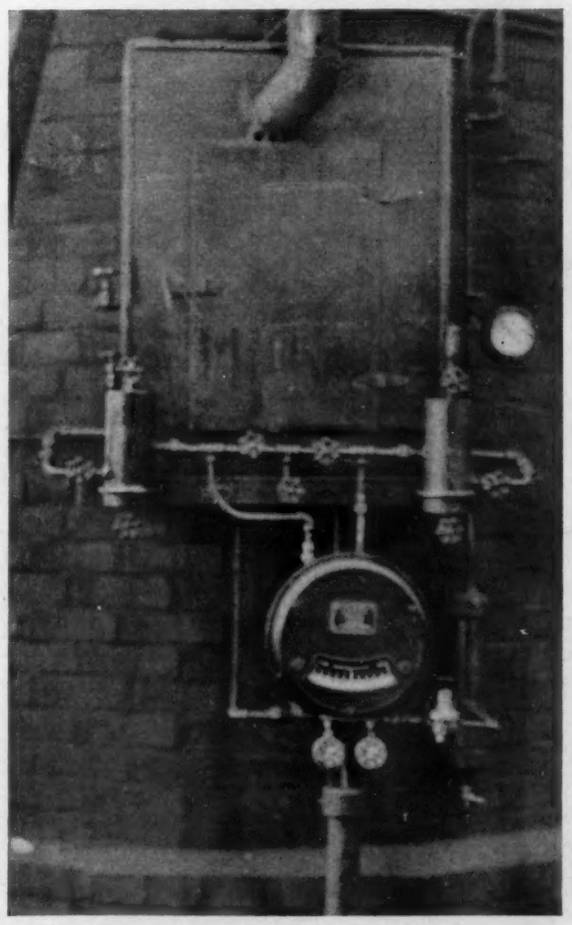
The two bottoms exchangers are connected in parallel in order that either may be repaired or cleaned, while the second will prove of sufficient capacity to maintain operation of the system. All pumping is done with Dean Brothers steam pumps with each operation provided with a stand-by unit so that uninterrupted service is assured. Exhaust steam from the pumps passes through a two-inch coil in the furnace, is superheated above 500°F. and used in the burner to atomize the fuel or gas oil. Steam requirements for the unit, according to metered results, are from 700 to 800 pounds per hour, which is considerably below the 1500 pounds per hour requirements specified in the construction contract.

FURNACE

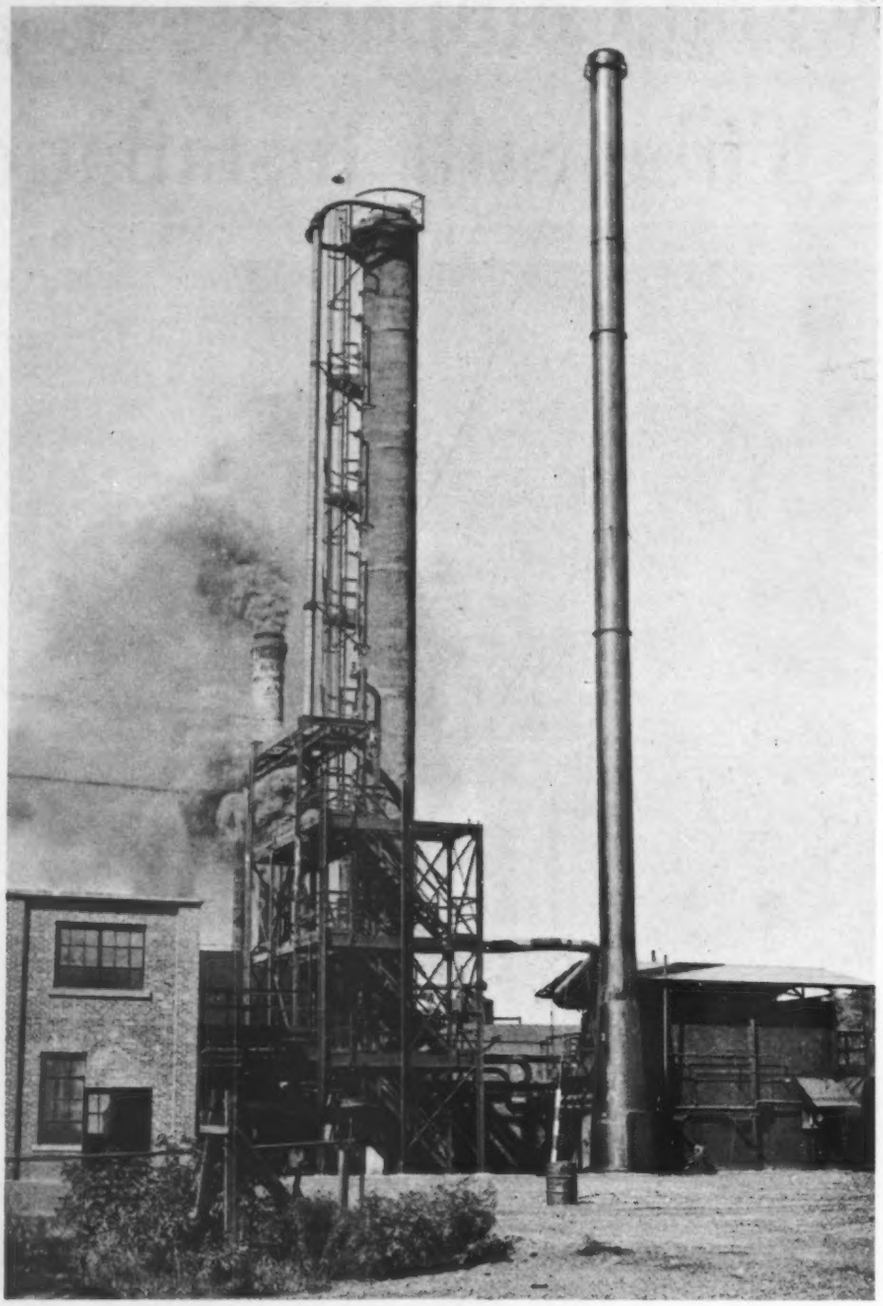
No steel plating is used to enclose the brick work of the furnace. The furnace is of double wall construction; two walls of nine-inch fire brick, or a total thickness of 18 inches, with, of course, the better grade of fire brick constituting the inner wall. The brick work does not support the tubes in which the construction follows customary practice in furnace design. The furnace is provided with five control points or adjustments as to draft regulation, and a steam flow indicator. It is fired with fuel oil and requirements 2½ percent of fuel based on the crude charged.

Two banks of tubes are hung in the furnace, with three-inch tubes used in the convection section and four-inch tubes in the radiant section. Crude entering at 325°F. and 95 to 100 pounds pressure, leaves the retort at an outlet pressure of eight pounds and a transfer line temperature of about 690°F. Stack temperature is 710°F, with the short breeching from the still to stack insulated to give a little more heat in the steel stack and thus provide better draft. The furnace design was carefully studied to avoid the prevalence of dead or blank spots and secure even, efficient distribution of heat to the tubes.

The heated oil leaving the still enters the tower



Liquid level of bottoms in the fractionating column is controlled by a Foxboro Stabilog.



Oil Creek Refining Company's 1500-barrel distillation unit at Titusville, Pa.

near the bottom to be flashed at a temperature of about 680°F. Gasoline is removed from the top of the tower at a temperature of about 265°F. Gasoline is pumped back over the column at a ratio of 3 to 1 as reflux, and at this rate of trimming and at the temperature mentioned 63 A.P.I. gravity motor fuel is produced with an end point of 360°F. Other grades of gasoline are produced by changing temperature and reflux conditions. The uppermost side stream removed is naphtha, which is conducted to the condenser box direct. The gasoline stream passes through the vapor heat exchanger previously mentioned, where it preheats the incoming crude to about 145-150°F. Both the gasoline stream and naphtha stream, representing 40 percent of the crude oil charged, are condensed or cooled in submerged cast iron condenser coils in a large steel condenser box. The same type of cooling system is employed for cooling the remaining side streams and the stock bottoms. These large boxes equipped with coils were used because they provide a margin of safety in the event of temporary failure of the water supply. Sufficient water is stored in the boxes to permit several hours operation, should water service be interrupted.

The second side stream taken from the tower is a 45/46 water white kerosene of 510°F. end point. It is removed at a tower temperature of about 400°F.

at the point of withdrawal and represents about 15 percent of the crude charge. The third stream is wax distillate, No. 2 color, and pressable, around 35/36 A.P.I. gravity, and removed at a tower temperature of 565°F. This stream represents about 18 percent of the charge. Before cooling it passes through an exchanger giving up part of its heat to the incoming crude. Under these conditions no slop wax stream is removed.

The lower side stream from the tower consists of fuel oil, representing around seven percent of the crude. The bottoms, which is a fine green stock, represents about 19½ percent of the crude charged to the plant. It has a 550°F. flash and 620°F. fire (open cup). Viscosity at 210 is 150 seconds.

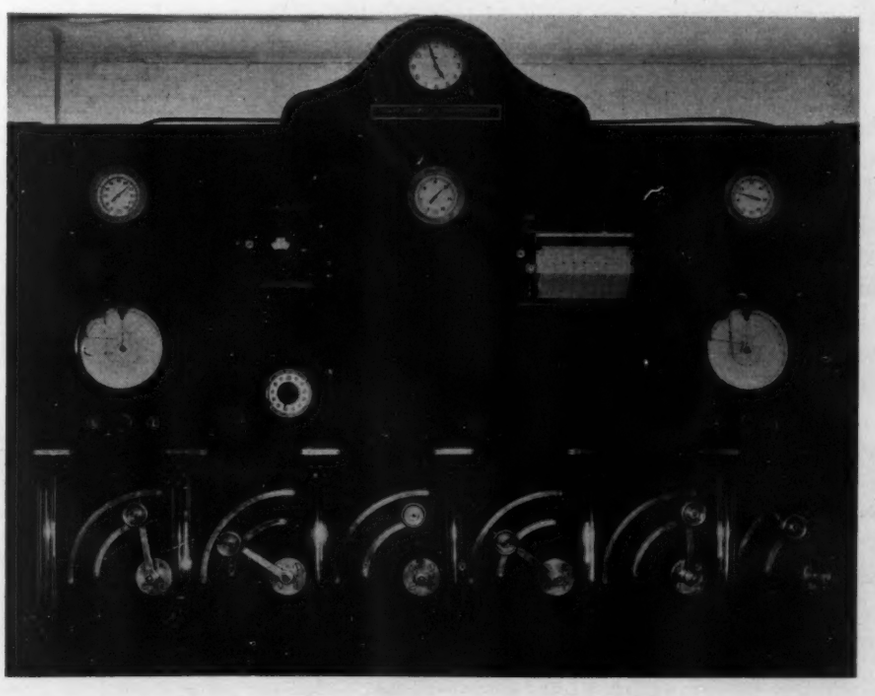
All fractions except bottoms or stocks are conducted through the control room. The gasoline, after condensation, flows through a large receiving or dewatering tank, which also acts as source of supply for the reflux pump. The streams do not flow through look-boxes in the receiving house, but the lines are manifolded to pass behind the control board. A portion of each stream is then diverted through gauge glasses mounted at the front of the control board, and in this manner the operator can constantly note the condition of each stream or fraction. Samples for testing are removed through small valves at the bottom of each gauge glass.

Control of the operations is secured by both Brown and Foxboro instruments. A Foxboro Stabilog controls liquid level of the hot bottoms or stock removed from the bottom of the fractionating tower. Both recording and indicating Brown potentiometers are used. The indicating potentiometer is operated electrically off of dry cell batteries, so that in event of failure of electric service, and therefore of the failure of the electric motor operated instrument, operation of the distillation system need not be interrupted. The recording instruments record temperatures of the overhead steam, side streams and bottoms. These points of control are duplicated on the indicating potentiometer, which, in addition, gives temperatures of inlet crude, transfer line, flash chamber, exhaust steam, bridge wall and stack.

As shown in the accompanying photograph of the unit, its design is very compact. The structural steel work supporting the heat exchange system is adequately large for workmen to perform their duties without over crowding. A steel platform extends from the control room to the safety platforms or working decks, and stairs lead directly down to the bottom of the tower and rear of the furnace. No valves are located at the top of the tower, which minimizes necessity for operators reaching that point, and the tower is provided only with a safety guarded steel ladder for use when occasional inspection is required.

The distillation unit was erected according to specifications of the Oil Creek Refining Company by Alco Products, Inc. Its construction began March 6, 1933, and it was placed on stream 60 days later, on May 6.

We are indebted to Mr. Frank J. McGraw for his permission to publish this description of his company's distillation system and for his helpfulness in the preparation of the discussion.



Control board in the receiving house. Gauge glasses provide operators with constant view of the flowing streams, Samples for testing taken from bottom of the gauges. Both motor and battery operated potentiometers are used.

Maintenance in the Lubricating Oil Plant

L. C. TRESCOTT

IN the lubricating oil plant, just as in other departments of the refinery, pumping equipment plays a leading part. In this article the author presents some views on pumps and pumping problems in the lube plant, based on many years of experience in this field. These views, naturally, are his own, but they will interest many engineers and operators whether they agree with his recommendations or not.

THE lubricating plant splits itself into three units: the acid treating plant, the contact treating plant, and the percolation filter plant. The first and last are well developed. We pretty well know what to expect in the line of operation and maintenance. The contact plant is newer. The industry as a whole is not too well acquainted with its details. It brings new problems into the treating and finishing of lubricating oils and among them are problems of maintenance.

The cost of maintenance will vary with the plant, its age, its facilities for getting the work done, and with the ideas on the subject of the men in charge. However, there are points which are common to all well regulated plants and a little attention to these will go far to lower direct maintenance costs and hold the waste due to lost time to a minimum.

In the lubricating oil plant as in other places in the refinery pumping equipment plays a leading part and there is no place where the maintenance of such equipment is more difficult or more important than the acid treating plant. Pumps here are used on a greater variety of service than any other place in the refinery.

ACID PUMPS

Acid pumps handle concentrated acid of various grades, from the concentration plant or storage to the acid treating plant and to the acid treating agitators as needed. For this service most operators prefer a reciprocating pump. The centrifugal pump is liable to give trouble by gas binding, and this type, especially when worn, is less satisfactory for transfer to other service, as will be noted later. A cast iron, all iron fitted pump, with a nickel steel rod has been found very satisfactory for this work. Such a pump may be used on this service for two or three years, and then sent to some less hazardous job, where it may be used indefinitely, depending on its condition. The location of pumps on this service also has a direct bearing on their life, and where possible they should be kept in a dry pump house. As a matter of safety as well as maintenance they should be inspected frequently.

SODA PUMPS

Soda pumps handle soda or alkali solutions of various strengths. They are used in circulating in making up mixes, in dissolving soda, and for transfer of the same to the neutralizing agitators. Centrifugal pumps have been found as satisfactory on this work as reciprocating pumps. Here an all iron pump is used and some concerns take the trouble to select a close gray iron. A centrifugal pump should be equipped with a steel shaft and impeller. The life of these pumps will be in the neighborhood of 15 years.

PUMPS FOR SOUR OIL

Pumps for sour oil transfer the treated but un-neutralized oil from the acid treating to the neutralizing agitators. In the case of an oil to be contact treated in the sour state the transfer is made to the contact treating plant. Reciprocating pumps are used on this service. The wear comes largely on the valves and seats and the largest loss of metal comes from reboring, both in the valve seats and the bodies.

For handling lighter oils, transformer oils, etc., centrifugal pumps are very satisfactory. Under average operating conditions the life of a pump on this work will be about 15 years.

SLUDGE PUMPS

Sludge pumps are used to draw the settled acid sludge from the bottom of the treating agitators, and transfer it to the dump or to the acid separators. Two types of pumps have been used successfully in handling acid sludges. The very nature of this service makes it necessary to have a rugged pump with large valve openings.

First the standard, large size block valve pump was used. A later type brought out was the hopper pump, or what is known around treating plants as the "sawdust" pump. In this there are but one set of valves: the outlet valves. The plunger acts as the inlet valve. Pumps for this work are of course outside packed.

The liquid or sludge ends of these pumps are of acid-proof metal. The wear occurs on valves, valve seats, plungers and liners. The liquid ends require a complete overhauling every two years. Valves weighed at such a period will show a loss of from four to eight

ounces of metal from a 16-ounce valve. With reasonable care the life of such a pump may be taken as 10 years of continuous service.

ACID OIL AND WEAK ACID PUMPS

Where acid separators are used, there are two types of pumping service in connection with their operation: The handling of acid oil and the transfer of weak acid.

The acid oil skimmed from the separators carries about 0.5 percent of weak acid (20° to 30° Be.) The temperature runs approximately 180° F. Both reciprocating and centrifugal pumps especially designed for this service, may be used here, though reciprocating pumps are generally preferred. All iron pumps are used, and will have a life of approximately seven years of continuous service.

The weak acid from the separators runs from 20° to 30° Be. and is pumped at a temperature of approximately 180° F. The work of these pumps is intermittent and their life will be in the neighborhood of 10 years.

The life of the various types of pump given in the foregoing is of course the life of the liquid end. Where a pump is given reasonable care and lubrication the steam end is good for many years.

The cost of keeping pumps in repair is probably more variable in a plant treating lubricating oils than in any other part of the refinery owing to the widely differing types of service under which the pumps of this department operate. However, a little care in the choice of metals, in the location of the pumps, so that where necessary they can be kept in the dry, and a system of inspection, frequent enough and thorough enough to keep constant records on the condition of the various pumps will do much to keep these costs at a low figure.

The basic operations of the treating plant are carried out in the acid treating and the neutralizing agitators. These are tall tanks with cone shaped bottoms and are seldom lead lined. A coating of hard sludge forms on the steel surface and protects it. It is necessary that the treating operations be carried out in such a way that this will be kept intact. A hot treat will often soften this and take it off. Too much water used in settling or water washing a sour oil in the treating agitator will also loosen this coating and set the agitator leaking at the seams.

Lead-lined agitators are generally used on lighter oils where the sour oils are to be water washed. With these one difficulty encountered is from the acid working through a small hole in the lead lining and attacking the shell from the inside. Sometimes considerable damage is done before the leak is discovered.

On the whole, repairs to treating agitators are few. Occasional bits of caulking are required. The most severe wear comes on the cone with the worst on the crown-sheet. This will vary with the temperature and strength of acid used, presence of moisture, etc., but under average conditions a crown-sheet can be expected to last five years. The life of the whole bottom may be taken at from 12 to 15 years, and the life of the agitator as a whole—well, that is anyone's guess.

With wash agitators the cones will require replacement in about 10 years, but will require little repair work in the meantime. Here, too, the life of the agitator as a whole is long.

Tanks for the storage of weak acid, lined with hard lead are still in fair condition after 15 years of service. Brick-lined agitators for the separation of sludge acid also have a long life and require few repairs. Trouble comes from a creeping which loosens the joints.

CONTACT TREATING

In the contact treating plant the equipment meriting the first consideration will be the pumps handling the clay-oil mixture. The farther one can go in adapting centrifugal pumps to this service the farther he will be from excessive maintenance charges and troublesome

One of the modern French refining plants.

delays. While centrifugal pumps have been generally used as filter feed pumps, there are still several places in the contact filter hook-up where it is considered necessary to install reciprocating pumps. These are usually placed at points where it is necessary to closely control the flow. Unless the viscosity of the mixture be so high that it cannot be handled in a centrifugal pump, it is hard to see why, with a properly designed pump and piping hook-up, such a pump will not give a regulation as accurate as would be required in any contact treating process.

The mention of a properly designed centrifugal pump brings us to a point which manufacturers of such pumps could consider with profit. While it is generally recognized in pumping practice that a centrifugal pump should be designed for the work it is to do, the fact remains that most of the centrifugal pumps in use in the oil business today are pumps which have been designed for some service where water or solutions of comparatively low viscosity were to be handled. As a result, slurry pumps which have given excellent results on the work for which they were designed have failed entirely when used on the more viscous oil-clay mixture.

There is a need for a centrifugal pump which will handle oil-clay slurry; the oil having a viscosity running up to 150 @ 210° F. (Saybolt) the pump to deliver the oil at a pressure up to 150 pounds; the operating temperature running from 70° to 120° F.

If the pump be of the closed impeller type the passages should be large and the impellers heavy. In one case a two stage pump with bronze impellers was put on service of this kind. The pump was of the regular type with a tangential discharge located at the bottom of the pump. Two troubles developed. The narrow passages and the material from which the impeller was made gave cause for unusual wear and the impellers were gone in short order. Then there were occasions when the temperature of the mix ran a little high. There was some vaporization and this trapped in the top of the pump casing, cutting down the flow.

Another two-stage pump which had been highly successful as a slurry pump working on fairly heavy muds was tried. This pump withstood the errosion well enough but it was impossible to build up the pressure, and the capacity was not anywhere near its rated limit. At the higher temperature this pump also trapped.

The pump which has given the best all around service within its pressure limits has been of the open impeller, verticle discharge type. The impeller in the best of these pumps had straight vanes and was heavily built. The openings through the pump were large. After several years of service there was little or no wear shown either on the impeller or the casing, and they held to their rated capacity. They have worked as high as 700° F., with steam and vapors coming off the mix without the least sign of trapping. Unfortunately pumps of this type are built only in single stage. Two pumps of this type piped in series worked very well up to 110 pounds pressure. There is no reason why such units cannot be compounded at the factory for this service.

It is a mistake in choosing a pump for this service to be too much concerned about efficiency details which enter into the choice of a pump for handling large quantities of water. Impellers designed for high efficiency are no longer efficient when worn, and in this work, wear is about the first thing that happens to high efficiency closed impellers with their narrow passages and thin curved blades. The simple centrifugal pumps with heavy open impellers and designed with a verticle discharge or some other means to prevent the trapping of air and vapors in the top of the casing, will give the best service.

The single-stage pump of this general type will give sufficient pressure for feeding the various types of filters and if the heating furnace be designed for circulation where the pressure does not exceed 35 pounds the single-stage will be satisfactory for this work also. Full iron pumps should be used. These will be found satisfactory for both the filter feed and for circulation at high temperatures.

In some cases centrifugal pumps are designed for close coupling to the motor. In every case there should be an intermediate bearing. This not only keeps the pumps aligned for even wear but takes up the thrust which sometimes throws the motor off magnetic center to cause overheating.

Probably the only case where this last can occur is where the pump is used for circulation, in and out of the same tank. Here there is little or no head on the pump and care should be taken to make the suction line as large as possible, otherwise the suction head will be so far out of proportion that in the case of an open impeller pump where the suction is connected to the center of one side of the pump casing, the impeller will be pulled slightly forward, and the rotor of the motor will be pulled off its magnetic center. A heavy overload will be shown with no apparent reason. While trouble of this kind is rare, it is worth noting as it is sometimes hard to recognize. Such a condition can be remedied by increasing the size of the suction line and balancing the head so that the impeller will ride back where it belongs.

In cases where it is found necessary to use reciprocating pumps the outside packed type should be specified. The block-valve type of pump which has been especially designed for handling muds and slimes will work well enough on oil-clay mixtures, but with the best of them more wear and trouble can be expected than from a centrifugal pump which is especially designed for the service. In many cases, of course, pumps at hand are pressed into service regardless of their especial fitness for the particular job. Where this is done the wear and tear must be taken as it comes.

The tendency in the oil business is almost always

toward the reciprocating pump. It is easy to control the output or the pressure over a wide range, by simply giving it more or less steam. It can also be used on a variety of jobs and oil men turn to it naturally for all classes of work. Most pumping operations call at one time or another for pressures above that of a single-stage centrifugal pump and the changes in viscosity due to wax, temperature, etc., call for a wide range of pressure for pumps in general use. In contact-treating practice, however, with the exception of places where the oil-clay mixture must be forced through a considerable length of tube in either a heater or an exchanger, the pressures are well within the range of a single stage centrifugal pump, and for handling slurries every effort should be made to use them. For the higher pressures, as has been noted before, there is a place for a multi-stage centrifugal pump, designed to handle oil of a reasonably high viscosity, and to withstand the action of an errosive slurry.

In the layout of piping for handling slurries all lines should be made as short as possible. Tees and plugs should be provided for cleaning lines which are liable to stoppage, and experience will indicate where these should be placed.

VALVES

In most cases the best valves to use are well built gate valves with parts easily replaceable. In order to keep down wear the size should be used which will allow these to be fully open when in operation. Throttling on any type of valve on this service is always the cause of undue wear and should be avoided wherever possible. In cases where the flow must be controlled at the valve the gates and the body will cut out fast, but there is little that can be done about it.

The wear and tear on furnace tubes and exchanger tubes in a well designed contact treating plant will not be unduly high. In many cases it has been feared that these would be cut out in short order by the abrasive oil-clay mixture, but experience has shown that there is no reason for concern. In the beginning there may be places in the circuit which will wear, but these can usually be eliminated by taking out sharp bends, changing pipe sizes, or by other means that common sense will dictate.

In this connection it may be said that return bends on furnace tubes and in exchangers do not cut out nearly as fast as may be expected, and that any of the well designed tube banks or exchangers will hold up well on this service.

With sectional exchangers care should be taken that all joints are kept tight and that vibration be held to a minimum.

The life of tubes in a furnace may be taken at three to four years on the average, and the maintenance cost on a furnace and tube bank in a plant capable of handling 2000 barrels per day will be in the neighborhood of $400.00 per year.

Most of the corrosion in the foam tank or separator of the contact treating system comes in the vent pipe where the acid vapors escape. Acid-proof metal can be used here to good advantage. Where baffles are used in foam tanks, they will last about two years.

If filters of the Sweetland type are used, practically the only item of maintenance is the filter cloth. When an oil is treated in a sour state or a neutral oil is filtered at a temperature above 220° F. it is necessary to use metal filter cloths. Much of the damage is done to the cloths when the cake is cleaned off on dumping the filter. Under no condition should a metal tool be used for this purpose. Wooden paddles should be employed and care should be taken not to break or dent the cloth. Two years is a fair life for a metal cloth.

Where a raw stock, such as Pennsylvania grade oil, or an oil which has previously been neutralized, is to be filtered in naphtha solution, the cake being steamed to rid it of naphtha and to dry it, cotton filter cloth is sometimes used. Under these conditions the life of a cloth will be about two weeks of coninuous operation.

Maintenance and repair costs on continuous filter units have been discussed in another article. (Refiner, Vo. 12, No. 10, Oct. 1933, page 396.)

Maintenance cost on blotter presses where such are used for the final straining of the finished oil, are negligible. The cost of blotters is an operating rather than a maintenance cost.

In laying out the contact treating plant and designing a system for handling slurries it must be kept in mind that the matter of wear and tear can assume great importance in the operation of the plant. It is not a case of designing for theoretical efficiency, but rather for undelayed operation. Considerable wear may occur and the whole layout should be made with the easy replacement of worn parts in mind. The designer should go out of his way to look for trouble as it is certain to crop up if there is the least opening. Equipment should be kept simple and as heavy as the case warrants. If this be done and standard, husky types of construction adhered to, maintenance costs will not only be kept low, but operation will be continuous.

In the percolation filter plant maintenance requirements are low. There are few, if any, cases of a percolation filter wearing out under regular service, and there are many which have been in use over 40 years. The principal repair here is in the case where a canvas blanket is used in the bottom of the filter. These blankets can be counted out after five to seven filter cycles. Metal screens in the newer types of filter bottoms are renewed about once a year. Pumps in this kind of a plant operate under ideal conditions. They have a long life and require few repairs.

Kilns and furnaces for reburning coarse clay, particularly furnaces of the hearth type, such as the Nichols-Herreschoff or the Wedge, require little in the way of maintenance. The older rotary kilns with the hotter

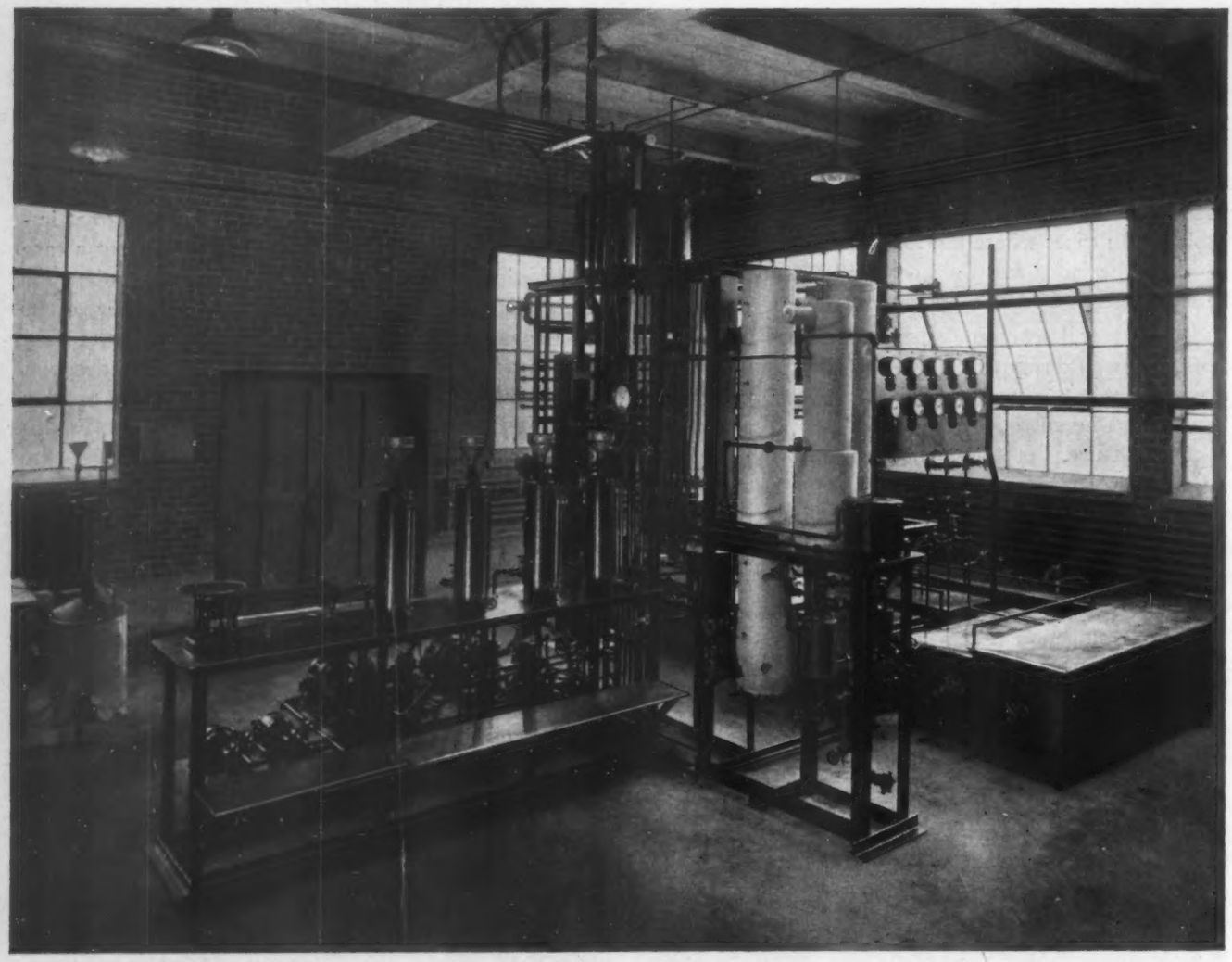
blasted flames were somewhat more expensive to keep up, but at that the maintenance cost is less than the cost when the same equipment is used for lime or cement burning, or even drying heavy materials.

Belt conveyors which are used in handling clay between the various units of the plant are also subject to a comparatively small amount of wear. Conveyor belts will have a long life except those which handle hot clay. Here the life of the belt is about one year.

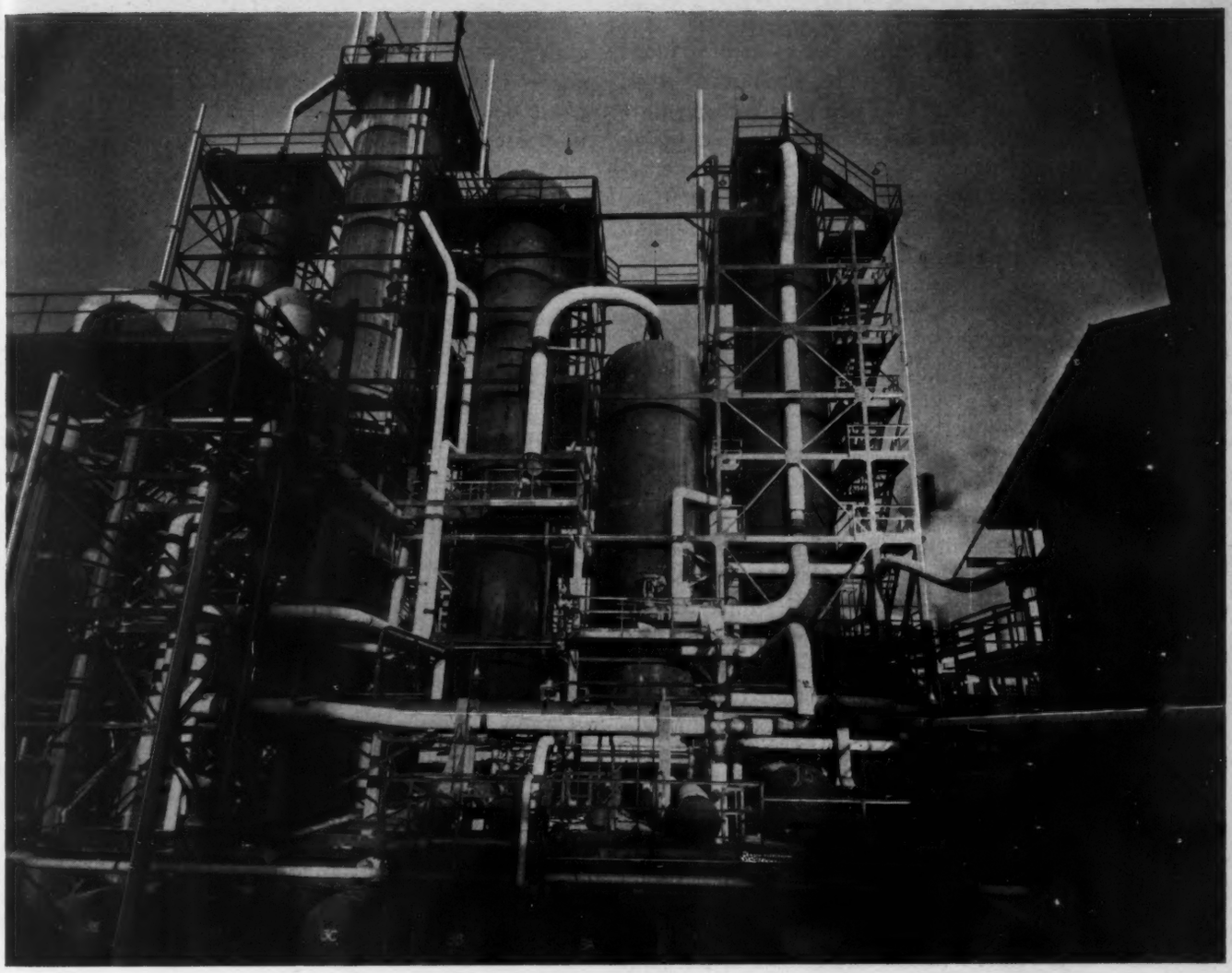
In oil refineries the method of figuring depreciation varies with the concern and its future plans. Just now this method is an uncertain proposition. It has been the custom with some concerns to amortise equipment on the basis of a life of 20 years, with equipment handling acid set at about 10 years. As long as changes were few this was fair enough, but now, with so many radical changes in processing coming up, equipment is often obsolete before it has more than started on its active life, and depreciation must be figured on the basis of obsolescence rather than on replacement. In some cases new equipment must pay for itself in from three to five years.

As processes change and equipment becomes more complicated it will be seen that the matter of maintenance takes on added importance. It should be clearly kept in mind that the cost of breakdowns and of defective equipment cannot be measured in mechanical costs alone. Lost time and lost production at critical times can easily run into a high figure. Maintenance in the lubricating plant as well as in other parts of the refinery should begin with the setting up of a system of regular and thorough inspection of all equipment. Breakdowns should be caught before they occur and repairs planned for and made at times when they will cause the least trouble and delay to productive plant operations.

This inspection should be carried out under the direction of the mechanical department and not left entirely up to the plant operators. And a point to be stressed is that this inspection should be made an important, fully established part of plant routine, and not a thing which is done whenever anyone happens to think about it or when someone wants a good excuse for a walk around the "yard."



A pilot cracking plant for projecting operating conditions and results in the design of combination systems. This installation is a model of the unit shown on page 489.



Towers of a 20,000-barrel per day combination unit—the world's largest cracking installation.

Combination Units

FINDING PLACE IN

Refining Industry

GEORGE ARMISTEAD, JR.
Chemical Engineer
Gasoline Products Company, Inc.

PROMINENT among the recent developments in refining practice has been the trend toward the close association of cracking with a variety of other operations. Out of this trend the individual type of unitary operation termed "combination" has been evolved. With its merits now well established by use, the combination process is appearing with increasing frequency in current construction and is recognizably assuming major importance among refining methods. Its advent is of general significance in marking a definite departure from the long-practiced segregation of the individual cracking and distillation operations.

The term "combination" is applied to the association of such functions as initial distillation of crude, viscosity breaking and naphtha reforming, with the main cracking operation, in self-contained systems. Usually it involves also the production of ultimate yields of final products. The refiner of today thus has available the facilities for carrying out the processing of crude oil to completion, including cracking, in a unitary operation. Foremost of the advantages

he may realize through this source are the conservation of waste heat from the cracking system, reduced labor and investment requirements per unit of fresh feed capacity, the reduced handling of intermediate products, and maximum yields of high anti-knock gasoline. The importance of these, both in the erection of completely new plants, and in supplementing existing capacity, explains the increasing adoption of combination operations by the industry.

RESEARCH BACKGROUND

The advent, and present advanced state of combination operations, reflect the achievements in fundamental research and process development work within recent years. While the advantage of associating other functions with cracking has long been recognized, the prevailing methods and the lack of knowledge of fundamentals were factors of restriction for many years. These limiting conditions restricted the combinations to elementary forms such as affecting crude topping, steam generation, and similar operations, with the waste heat of cracking systems. Indeed, the long-existing size limitations of cracking systems, and the lack of precise design data practically excluded more advanced combinations, and favored complete separation of individual operations.

Eventually, it was development work, enlarged in scope, which proved the practical possibility of combination design. Laboratories whose equipment included pilot plants, duplicating in miniature the operating conditions of the refinery, enabled research to determine the fundamental factors and to establish their inter-related values and effects in terms of plant operation. From development work came many advances including primary cracking or viscosity breaking which was affiliated with the main cracking operation, pressure tar flashing, and naphtha reforming. The development of redistilled circulation, wherein a clean heater feed is prepared by distillation in the cracking fractionation system, greatly facilitated the progress, in allowing much higher temperatures and cracking rates to be employed, and increasing the operating range of cracking operation.

In addition to means of applying laboratory results precisely to equipment of commercial size, the research and development work, responsible for this progress, yielded fundamental operation and design data which were valuable. In respect to the complex combination systems, this satisfied an important requirement, in the degree to which precise design is required to furnish adequate capacity and flexibility of inter-related parts, without resort to the use of inordinate safety factors. The design of each unit is a separate problem defined by the processing requirements and the raw stock. Accordingly, it has been indispensible that optimum operating methods and design, developed on laboratory or semi-plant scale equipment, be applicable with accuracy to the commercial design. To this end, the research has embraced the field from development of fundamentals to extensive correlations of the small-scale and plant equipment. The results achieved are reflected in the commercial installations, now in use, whose actual performance has duplicated within almost negligible limits the performance for which they were designed. Finally, the flexibility necessary for optimum operation has been secured, without material over-capacity of individual parts.

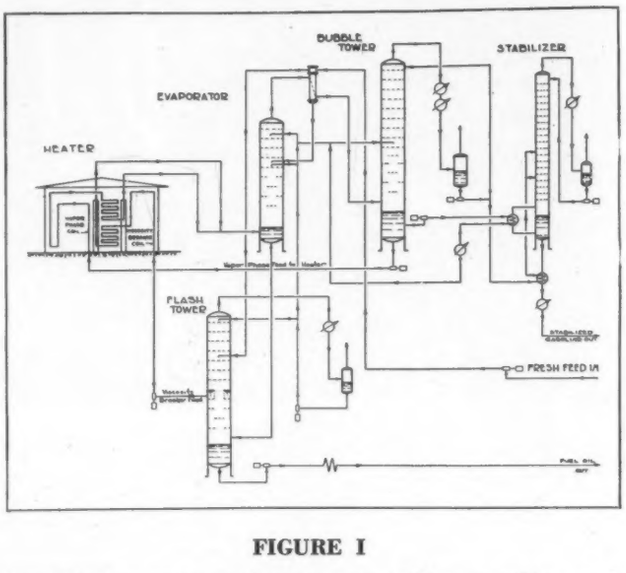


FIGURE I

Combination unit employing vapor phase cracking and viscosity breaking for residual stocks.

Consideration of representative types of combination operation is properly introduced by an example of one of the simpler forms, designed for the handling of reduced crude, as recently erected by The M. W. Kellog Company for a Mid-Continent refiner. A diagram of this type of installation is presented in Figure I. Generally, the operations comprise primary cracking, vapor phase cracking, fuel oil flashing and naphtha stabilization.

Fresh reduced crude feed is introduced to the fuel flash tower to be preheated with hot flashed vapors, and is collected on a trap-tray, with included heavy condensate, to be passed through the primary cracking section of the heater which discharges into the high pressure evaporator. The feed for the vapor phase section of the heater is taken from the base of the bubble tower, the boiling range of this stock being regulated by the temperature of the evaporator top, so as to exclude high boiling fractions unsuitable for the vapor phase temperatures. After passing through its section of the heater, and attaining a temperature of about 960°F., the vapor phase cracked stream emerges to join the discharge from the primary cracking coil and enter the evaporator. The composite fuel oil in the evaporator, under about 200 pounds pressure, is released to the fuel oil flash tower, under low pressure, where it is reduced down

to the desired viscosity and the evolved cycle stock vapors are returned to the cracking system. The stabilizer operates as an integral part of the system using recycle gas oil reflux as the source of heat.

It will be noted that the heater is of the dual combustion chamber type, separate radiant sections being provided for the two streams, to facilitate control of radiant heat absorption, although both are served by a common convection zone. This arrangement affords the flexibility of two individual furnaces, yet permits the advantageous use of the convection surface and confines the total surface within a single setting.

The operating results of this installation on a reduced crude may be illustrated by the following data, typical of approximately 300 hours of operation:

FRESH FEED

Mid-Continent Reduced Crude, 23.2° A. P. I., Comprising 60-65% of Original Crude.

YIELDS

Gasoline	42.31%
Fuel Oil	49.03
Gas and Loss	8.66
Total	100.00%

PRODUCTS

	Gasoline	Fuel Oil
End Point	400	
Octane No. CFR-M	70	
Visc./122 Furol		196
B. S. & W.		.24%

While representing the desirable plant operating conditions, these results do not define the range generally characteristic of the operation. The operation is effective on a reduced crude, or similar residual stock, by virtue of the combined fuel oil flashing and primary cracking steps, and in a more or less recognizable form it appears in other systems.

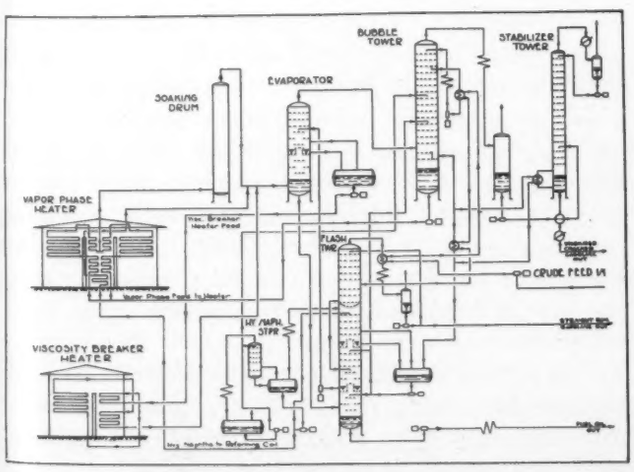


FIGURE II

A combination unit for crude feed providing preliminary distillation, naphtha reforming and cracking to completion

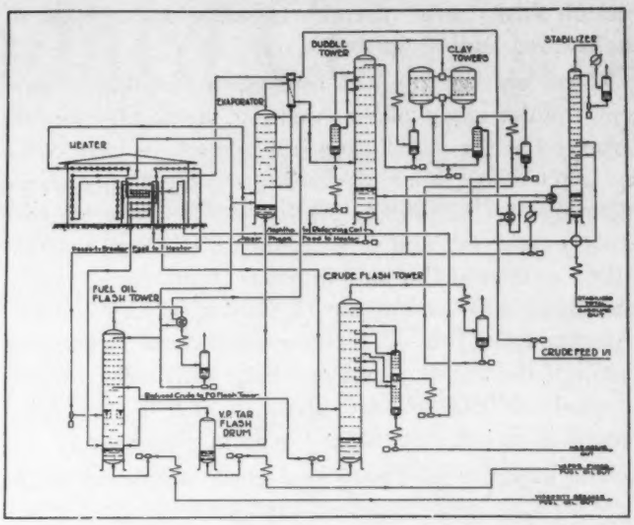


FIGURE III

Combination unit for crude feed, producing ultimate yields of products direct and employing a single heater and a cycle somewhat modified from that in Figure II.

More complex forms of the combination units, as employed for running crude to ultimate products, are shown in Figures II and III. Erected by The M. W. Kellog Company, and put in service within the last 12 months, these units represent the advantageous association of crude topping, primary cracking, vapor phase cracking, fuel oil flashing, naphtha reforming, clay treating, and naphtha stabilization. From crude oil charge, they produce a stabilized low gum gasoline of the desired anti-knock rating, fuel oil, and gas, directly from the system. Light fuel or furnace oils may also be trapped out directly if desired. The compactness of the equipment serving these functions permits very large quantities of crude to be accommodated without excessive size, which is reflected in outstanding degree in the processing of 20,000 barrels of crude to completion, daily, by one of these units. The advantage realized through the elimination of handling of intermediate products is obvious.

From the diagrams, it will be noted that the crude oil feed, after preheating with waste heat, is flashed to separate light and heavy straight-run naphtha cuts, the former being ready for incorporation in the finished gasoline, and the latter to be subjected to reforming. In the unit shown in Figure III, provision is made for the additional separation of a kerosene cut in the crude distillation. The reduced crude remaining from this pre-distillation is preheated by contact with hot vapors in the fuel oil flash tower, but Figures II and III show different methods of its subsequent handling. The unit in Figure II further preheats and distills the reduced crude, by introduction to the high pressure evaporator prior to primary cracking. The other unit, however, passes the reduced crude direct from the fuel oil flash tower through the primary cracking coil, and back into the

fuel oil flash tower, thereby favoring segregation of the cracked and virgin stocks.

These units employ a redistilled circulation system, for the vapor phase cracking, similar to the one observed in the installation in Figure I. In both cases the circulating stock is carefully controlled in boiling range for suitability for the vapor phase temperature employed, and it is made up of fractions distilling over into the bubble tower, from the evaporator, along with an amount of similar quality condensate from the fuel oil flashing operation. In passing through the vapor phase cracking coil, temperatures upward of 950° F., are attained, and the emerging stream is, in one case, soaked in an insulated vessel.

The naphtha reforming operation is applied to the heavy straight-run naphtha cut by digesting this material in a coil at temperatures over 1000° F., and under pressures of 500 pounds, and higher—the total products from this heat treatment being discharged into the high pressure evaporator, and handled subsequently with the vapor phase cracked vapors. The unit in Figure III is provided with a withdrawal point, for heavy naphtha, on the cracking fractionator, which permits inclusion of this stock with the feed to the reforming coil. The total vapors leaving the cracking system, comprise cracked naphtha produced in the primary cracking, vapor phase cracking and reforming, and can be subjected advantageously, to Gray treating, in the vapor phase, as is shown in Figure III. The light straight-run naphtha not requiring such treatment is segregated, and combined with the heavier product after treating.

HEATERS

The heating facilities, employed in these more complex combination operations, present numerous unusual features. The heating of the three or more individual streams, characteristic of such operations, as well as the handling of extraordinarily high throughputs, have favored the use of the multi-stream heaters shown in the accompanying figures. This trend has carried with it the necessity of precise design, as well as unique arrangements to preclude limiting interference between individual streams, or the necessity for large over design in securing a practical degree of flexibility.

Figure II will be seen to present an individual heater for primary cracking, and another for naphtha reforming and vapor phase cracking together. In the case of the latter, the two radiant sections serve similar functions in vapor-phase cracking parallel streams. The vapor-phase feed to this heater amounts to more than 1300 barrels per hour. In Figure III, the unit utilizes a single heater only, whose duties comprise the heating of the four separate streams required by the operation. It will be observed that the separate radiant sections serve separate functions, while still others are served by the convection zone.

The performance of these latter types of combination unit, since they have been put in service, has been fully in accordance with their theoretical advantages. The following representative data are typical of the results secured on the running of a 36-37° A.P.I. Mid-Continent crude through one of the larger units above described and they illustrate the results obtainable commercially with such an operation.

YIELDS

Straight Run Light Gasoline	15.7	
Cracked Gasoline, Stabilized	50.5	
Total Gasoline		66.2
Fuel Oil		24.8
Fuel Gas and Loss		9.0
Total		100.0

FUEL CONSUMPTION

Total for Unit—% of Crude Charge 5.10%.

PRODUCTS

	Composite Gasoline	Fuel Oil
Grav. A. P. I.	61.0	9.4
Visc./122 Furol		175
B. S. & W.		.54
Octane No. CFR-M	70	
IBP	84	
20%	164	
50%	254	
90%	382	
E. P.	401	
% Rec.	96.0	

OUTLOOK FOR THE FUTURE

The prospects for future application of the combination operation may be perceived in the erection now under way of a unit for crude oil feed whose capacity will far exceed those of existing self contained systems for similar duties. This installation will accommodate 32,000 barrels of crude daily. It will embody substantially the same functions as those of the unit in Figure III for processing crude to completion.

The comparatively recent advent of this type of operation has, in the light of its demonstrated capabilities, supplied the refiner with a new tool which fulfills a definite need. Accordingly, it is to be expected that the future will witness an increased tendency toward establishing the main cracking operation as the basis around which all heat treating and distillation operations will be closely centered. The new 32,000-barrel unit for complete crude processing illustrates the extent to which this may be carried. With continued design proficiency, the advantages now being realized from a limited number of combination units should accrue to a greatly increased extent to the industry in general.

The Introduction of Standard Costs *in the* Oil Refining Industry

G. CHARTER HARRISON,
Management Consultant, Chicago.

IN two previous articles the writer discussed the general principles of standard costs in relation to the application of these principles to the business of oil refining. In this article he gives some practical suggestions regarding the introduction of standard costs in an oil refinery. It goes without saying, that to carry the standard cost idea to its logical conclusion in a large refinery involves ramifications entirely outside of the scope of a magazine article. The underlying technique, however, can be simply demonstrated and to do this is the primary purpose of this discussion. Mr. Harrison's previous articles appeared in the Refiner, issue of December, 1932, page 611 and the issue of March, 1933, page 104.

IT has been a source of some wonder to the writer that standard costs have not made greater headway in the oil industry and he has taken some pains to arrive at the reasons underlying the hesitancy on the part of this industry to embrace a method of control, so simple, so effective, and so logical, that in many other industries it is regarded as the only sensible way in which to keep costs.

Fundamentally, this failure on the part of the oil industry to take advantage of an improved method is due to a lack of understanding on the part of the operating man as to the nature of the benefits which he would receive from the introduction of standard costs, and, on the part of the accountant as to the practicability of introducing standard costs in so complex an industry, from a cost standpoint, as that of oil refining.

Testimony from those who have used standard costs, and, have derived great satisfaction therefrom, is infinitely superior, of course, to claims made by non-users that the standard cost plan is impracticable and of little value in the oil industry. It is believed that the first introduction of standard costs in any complete form in a large modern refinery was made by The Atlantic Refining Company. This company has been operating standard costs for over two years which would seem to be sufficient time to thoroughly test out the plan. Furthermore, before introducing standard costs, the company was operating a highly perfected "actual cost" plan and therefore was in a position to make comparisons of the relative advantages and disadvantages of the former plan with the present plan under which standard costs are superimposed on the actual costs.

STANDARD AND ACTUAL COSTS

The writer wishes to emphasize the point made in the last paragraph—standard costs do not replace actual costs, they merely expand the scope of the system so that in addition to giving the management the actual costs of products the system also gives cost data designed specifically to give the operating man the kind of cost information he needs in the way in which it will be most useful to him in his efforts towards cost reduction. In The Atlantic Refining Company system little change was made in the existing cost plan, as far as it related to securing actual costs.

The thought will naturally arise in the mind of the reader at this point that if we superimpose standard costs upon actual costs, and in effect operate our cost plan on two bases, we will greatly increase, even if we do not double, the cost of operating our cost department. But we have testimony to the effect that this is not so. In a paper read at the meeting of the American Institute of Chemical Engineers in December, 1931, under the title of "Cost Accounting and the Chemical Engineer," written by A. G. Peterkin and H. W. Jones, of The Atlantic Refining Company, the following paragraph appears:

"But cost departments are expensive—what about the increased costs of the costs themselves? Here again the new systems have followed the trend of modern industrialism. By focusing expert, intelligent and intensive study on the problem beforehand and by applying a few simple principles, an automatic system of analysis is devised whereby the computation of periodic analytical statements becomes a mechanical routine easily performed by relatively inexpensive labor. The thinking is done beforehand; the clerical force adds, multiplies and divides, and enters the results in the right column."

In the article being quoted from we have direct testimony of practical operating men as to the benefits derived from the use of standard costs. As regards the refinery cost systems which do not embrace the use of standards, they make the following comment:

"The general accounting system of a company periodically lays before the general management balance sheets and operating statements showing the current assets and liabilities, the gross income, the

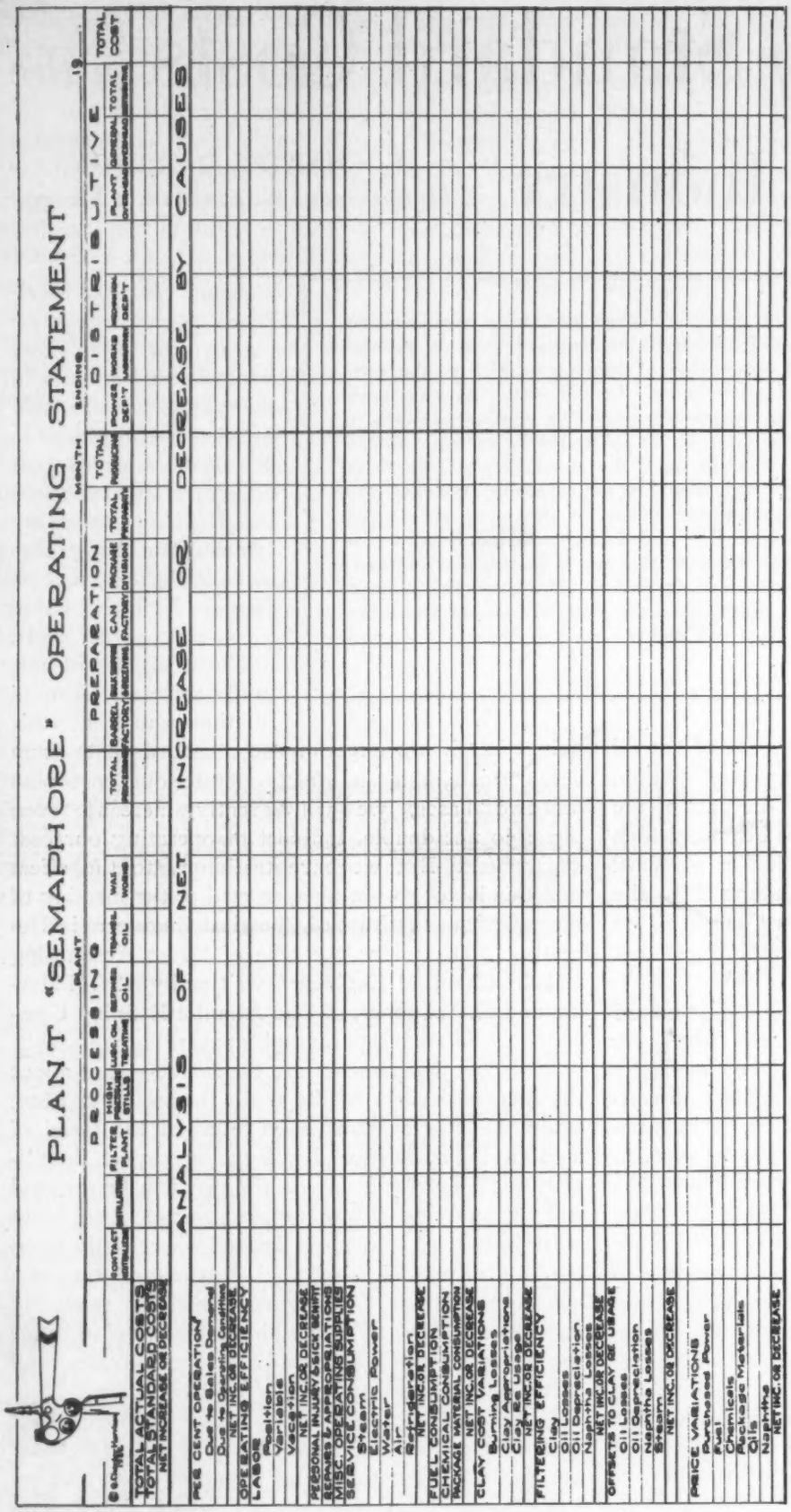


FIGURE 1

Form of cost statement to meet requirements of the management of a refinery operating under complex conditions.

cost of selling, the cost of manufacture, and finally the net profit for the period. The cost system has contributed nothing to these figures except the evaluation of inventories of partly finished and finished goods, which is necessary to determine profit or loss . The total of the expenses distributed by the cost procedure must, of course, equal the total expenditures shown by the general accounting system.

"In the past the average cost system has been a post-mortem instrument—an analysis intended to show the extent to which individual activities have contributed or failed to contribute to a successful showing. Such statements represent water-over-the-dam, and insofar as they covered extensive periods contributed nothing or little to day-to-day economy and good judgement in handling current exigencies. They did provide, however, information upon which decisions concerning long time policies could be based, and in addition served as a point of departure for investigations into the past efficiency of management."

The motivating effects of standard costs are described as follows:

"This method of plant management then consists first in the clean-cut delegation of responsibility throughout the organization; it entails a forecast or budget of production volume, rate and cost over a suitable period, itemized to correspond with individual responsibility; it entails a parallel record of accomplishment; and finally it furnishes to individuals and groups of individuals a statement comparing the anticipated with the actual results of their activities. It does not stop at superintendents or foremen but reaches down to the individual operator or group of operators. The whole scheme is directed towards using to the limit the abilities of every employee and making it possible for him to employ to the fullest extent whatever initiative and na-

tive intelligence he may possess. If the plant is adequately equipped with measuring instruments a foundation is laid for bonus incentives, which usually put a keen edge on those qualities either in the individual or the group. The standard cost system makes the method workable inasmuch as it automatically separates factors beyond the control of the individual, leaving bare those which are affected by his judgement and intelligence. Furthermore it makes possible the detailed routine expense analysis of great masses of operating data at a minimum of expense."

Testimony from the accounting division regarding the advantages of standard costs in the oil refining industry is given in an article by V. L. Elliott, comptroller of The Atlantic Refining Company, in the following statement:

"Standard costs are in use in at least two large oil refineries. Doubtless, in time they will find their way throughout the oil industry. The amount of work necessary to operate the system is usually no greater than other cost systems—and sometimes is considerably less. With standard costs, certainly the management knows more of the 'why' of its business, and what will happen as conditions change."

"WHY?"

In that word "why" Mr. Elliott strikes the keynote of the modern standard cost plan. When he read the above statement the writer was immediately taken back 20 years when he presented what was probably the first complete standard cost statement ever handed to the executive of a business. On this statement all of the costs and expenses were shown in relation to standards, increases over standard were shown in red, decreases in black. The net result was a very large red figure. The president looked at it and asked "why?" And it was as a result of the attempt to answer that question, to analyze cost variations according to "causes", that modern standard cost accounting developed.

It is not so easy to answer that question "why" as might appear. Take for instance the analysis of the causes of a variation from standard in still costs per 100 gallons. Such a variation may result from any or all of the following causes:

(1) Operating the stills less than the standard hours due to lack of demand from the sales department.

(2) Operating the stills more hours than standard for the throughput.

(3) Using more or less steam per 100 gallons than standard.

(4) Variations from the standard cost of producing steam.

(5) Variations from the standard consumption of fuel per 100 gallons of throughput.

(6) Variations from the standard price of fuel per fuel unit.

(7) Variations from the standard labor gang.

(8) Variations from the standard labor rates per hour paid to the gang.

(9) Variations in the number of working hours in the month as regards salaried workers.

(10) Variations in repair costs.

(11) Variations in general burden.

The most important distinction to be made in any cost variation analysis is that between cost variations which are controllable by operating men and those outside of their control. A still foreman, for instance, can to some considerable extent control steam for consumption but the cost of producing steam is outside of his province. He can control still-running time to some extent but if his department is down part of the month, due to lack of sales demand, increased costs resulting from this condition are entirely outside of his control.

If more than one type of crude is run the problem becomes slightly more complex because each crude will have a different standard for still-hours, fuel, and steam consumption, per 100 gallons of throughput.

Now the analysis of cost variations, like any other engineering analysis, involves the use of formulae, and the use of these formulae in conjunction with properly designed cost variation sheets renders the analysis of cost variations a mere matter of automatic mechanical routine.

The principles underlying the analysis of cost variations will be easily understood by considering the following simple example in which purely arbitrary standards and figures have been used.

Assume that we have a batch of stills for which the following standard costs per still hour, excluding process steam and fuel, have been determined:

(a) Standard working days in standard month	25
(b) Standard still hours in standard month	2,000
(c) Standard fixed costs per standard month	$30,000
(d) Standard variable costs per standard month	$10,000
(e) Total standard costs per standard month (c plus d)	$40,000
(f) Standard costs per still hour $\frac{e}{b}$ $\frac{\$40,000}{2,000}$	$20.00

Assume further that two classes of crude are run —"A", and "B" with the following cost characteristics:

	Crude "A"	Crude "B"
Still hours per 100 gals.	.01	.007
Process steam per 100 gals.—pounds	50	40
Fuel per 100 gals.—pounds	30	25

Assume that the standard cost of producing steam

to be 40 cents per 1000 pounds and the standard cost of fuel to be $1.50 per 1000 pounds. The standard still costs per 100 gallons for crudes "A" and "B", respectively, would then be as follows:

	Crude "A"	Crude "B"
Still costs at $20 per hour	$0.2000	$0.1400
Steam costs at 40 cents per 1000 pounds	0.0200	0.0160
Fuel costs at $1.50 per 1000 pounds	0.0450	0.0375
Total costs per 100 gallons	$0.2650	$0.1935

Now let us assume that in a certain month with 24 working days there were run 7,500,000 gallons of Crude "A", and 11,000,000 gallons of Crude "B" with still running times of 780 and 760 hours respectively. The balance of the time the stills were down owing to lack of orders. The total consumption of process steam was 8,000,000 pounds and of fuel was 6,000,000 pounds. The prices of steam and fuel were 42 cents and $1.40 per 1000 pounds respectively. The actual fixed expenses were $28,000 and the variable expenses were $9,000.

A comparison of actual and standard costs would then show as follows:

Actual Costs:	
Fixed expenses	$28,000.00
Variable expenses	9,000.00
Steam 8,000,000 pounds at 42 cents per 1000 pounds	3,360.00
Fuel 6,000,000 pounds at $1.40 per 1000 pounds	8,400.00
Total actual costs	$48,760.00

Now the standard value of the production amounted to only $41,160, made up as follows:

Crude "A" 7,500,000 gallons at standard still cost of $0.265 per 100 gallons	$19,875.00
Crude "B" 11,000,000 gallons at standard still cost of $0.1935 per 100 gals.	21,285.00
Total standard value of production	$41,160.00

We have an excess cost over standard therefore of $7,600.00 as follows:

Actual costs, as above	$48,760.00
Standard costs as above	41,160.00
Excess cost	7,600.00

In making an analysis of this variation by causes, our first step would be to analyze the standard cost of the production as follows:

		STILL HOURS			STEAM		FUEL	
			Standard		Standard		Standard	
Crude	Thruput	Actual	Per 100 Gals.	For Production	Per 100 Gals.	For Production	Per 100 Gals.	For Production
A	7,500,000	780	.01	750	50	3,750,000	30	2,250,000
B	11,000,000	760	.007	770	40	4,400,000	25	2,750,000
Totals	18,500,000	1,540	...	1,520	...	8,150,000	...	5,000,000

We now have all the data necessary to make up our cost variation analysis, which data we may marshall as follows:

Standard Data

A—Working days in standard month	25
B—Standard still hours in standard month	2,000
Standard cost of fixed expenses:	
C—Per standard month	$30,000
D—Per working day C/A	$1,200
E—Per still hour C/B	$15
Standard cost of variable expenses:	
F—Per standard month	$10,000
G—Per still hour F/B	$5
Total standard costs:	
H—Per standard month C plus F	$40,000
I—Per still hour H/B	$20
J—Standard steam cost per 1000 pounds	$0.40
K—Standard fuel cost per 1000 pounds	$1.50

Data for Current Month

a—Working days in month	24
b—Hours stills operated	1,540
c—Standard still hours for production	1,520
d—Standard steam consumption for production	8,150,000
e—Standard value of standard steam consumption $\frac{(d \times J)}{1000}$	$3260
f—Standard fuel consumption for production pounds	5,000,000
g—Standard value of standard fuel consumption $\frac{(f \times K)}{1000}$	$7500
h—Actual steam used—pounds	8,000,000
i—Actual steam used at standard price— $\frac{(h \times J)}{1000}$	$3200
j—Actual steam used, at actual price— $\frac{(h \times 42 \text{ cents})}{1000}$	$3360
k—Actual fuel used—pounds	6,000,000
l—Actual fuel used, at standard price— $\frac{(k \times K)}{1000}$	$9000
m—Actual fuel used, at actual price— $\frac{(k \times \$1.40)}{1000}$	$8400
n—Standard fixed charges for working days in month—(a x D)	$28,800
o—Standard fixed charges for still hours operated—(b x E)	$23,100
p—Total standard costs for hours stills operated (b x I)	$30,800
q—Total standard costs for standard still hours value of production (c x I)	$30,400
r—Standard variable costs for hours stills operated—(b x G)	$7,700
s—Actual fixed expenses in month	$28,000
t—Actual variable expenses in month	$9,000

Now the general principle underlying the analysis of cost variations is to so arrange the data that comparisons are made of items as regards which there is only one element of difference. For instance, take items "l" and "m" above which represent, respectively, the total pounds of fuel used figured at the stand-

ard price of $1.50 per 1000 pounds, and the total pounds of fuel used figured at the actual current price of $1.40 per 1000 pounds. The only element of difference between these two items is, obviously, that of the difference in price of 10 cents per thousand pounds. The difference between these two items, therefore, will represent the cost variation due to a change from the price of fuel, as follows:

(l)—Actual fuel used at standard price	$9,000
(m)—Actual fuel used at actual price	8,400
Saving due to reduction in price of fuel	600

This is obviously correct—the price of fuel fell 10 cents per thousand pounds, 6,000,000 pounds were used which figured at 10 cents per thousand pounds represents a saving, or cost reduction, of $600.

In the system of cost formulae developed by the writer, actual cost items are always deducted from standard cost items so that if the upper figure is more than the lower a saving is indicated, conversely if the lower figure, namely the actual cost, is greater than the upper, this indicates that the actual expenses are in excess of standard and that there has been a cost increase due to the particular cause in respect to which the analysis is made. Savings are invariably shown on cost variation sheets in black, and losses, or cost increases, in red.

Applying this principle to the analysis of the total increased cost of still production of $7,600, works out as follows:

ANALYSIS OF COST VARIATIONS IN STILLS BY CAUSES

Cause of Cost Variation	Factors	Increase	Decrease
Lack of Sales—			
o—Standard fixed charges for still hours operated	$23,100		
n—Standard fixed charges for working days in month	28,800	$ 5,700	
Calendar Variations—			
n—Standard fixed charges for working days in month	$28,800		
C—Standard fixed charges for standard month	30,000	1,200	
Still Operating Efficiency—			
q—Total standard cost of still production	$30,400		
p—Total standard costs for hours stills operated	30,800	400	
Steam Consumption—			
e—Standard value of standard steam consumption	$3,260		
i—Actual steam used at standard price	3,200		$60
Fuel Consumption—			
g—Standard value of standard fuel consumption	$7,500		
l—Actual fuel used at standard price	9,000	1,500	
Cost of Producing Steam—			
i—Actual steam used at standard price	$3,200		
j—Actual steam used at actual price	3,360	160	
Price of Fuel—			
l—Actual fuel used at standard price	$9,000		
m—Actual fuel used at actual price	8,400		600
Fixed Charge Expense—			
C—Standard fixed charges per standard month	$30,000		
s—Actual fixed charge expense in month	28,000		2,000
Variable Expense—			
r—Standard variable costs for hours stills operated	$7,700		
t—Actual variable expenses in month	9,000	1,300	
Total Increases and Decreases		10,260	2,660
Net Increase			7,600
		$10,260	$10,260

Summarizing, therefore, our increase in the costs of the stills of $7,600 was made up as follows:

Outside of Plant Management Control		
Lack of sales	$5,700	
Calendar variations	1,200	
	6,900	
Less saving in price of fuel	600	$6,300
Within Control of Plant Management:		
Still efficiency		$ 400
Fuel consumption		1,500
Cost of producing steam		160
Variable expenses		1,300
Total increases		3,360
Less savings:		
Fixed expenses	$2,000	1,300
Steam consumption	60	2,060
Net increase as above		$7,600

Now in actual practice the routine of making cost analyses is a much simpler matter than would be suggested by a consideration of the above routine, which illustrates the simple mathematical procedure underlying the analysis work which when established is merely a matter of mechanical routine. As was stated in the quotation given earlier " . . . an automatic system of analysis is devised whereby the computation of periodic analytical statements becomes a mechanical routine easily performed by relatively inexpensive labor. The thinking is done beforehand; the clerical force adds, multiplies, and divides, and enters the results in the right column." Subtraction was left out in the remark just quoted but, as will be noted from the illustrations given above, subtraction

is the arithmetical process most used in cost analysis.

The speeding-up of cost variation analysis work, and the ability to delegate this to operators of office machinery with no understanding of the principles underlying the results they secure, is accomplished as follows:

(1) By the use of properly designed cost variation sheets which are so arranged that the routine work to be done follows a natural flow of simple automatic computations the accuracy of which are ensured by self-balancing procedure.

(2) The duplication of all standard data so that copying is avoided.

(3) The linking-in of the standard cost system with the actual costs so that data as to actual costs only requires to be recorded once.

The setting of standards is a somewhat more complex procedure than indicated in the example given above under which still expenses were divided as between "fixed" and "variable". There are of course, several kinds of fixed expenses and also various forms of variable expenses considered from the standpoint of cost analysis. In the case of fixed expenses, for instance, we will have some expenses which represent a fixed charge per month, as for instance, the cost of a salaried employee or depreciation, when this is apportioned on a calendar monthly basis, and then again we have certain expenses which are fixed as long as a department is operating but will be eliminated or reduced when it is shutdown. Standard costs in addition would require to be very finely sub-divided by expense accounts.

Standard costs in an oil refinery should furnish cost variation data to each responsible employee showing how his results compared with the standards set up for him. And as far as it is possible to do so, every man who is judged by his performance in relation to a standard should be sold on that standard.

Operating a standard cost system along the lines described compels the accounting department to talk the language of the operating department and to express information in terms intelligible to the operating man. The writer knows of no procedure which will create such a strong bond of understanding and mutual helpfulness between the accounting and operating divisions as a properly designed standard cost system. As for the operating superintendent, once he realizes the aid which a standard cost system is to the operating man, in the words of a famous English advertisement he "won't be happy 'til he gets it."

Whereas cost variation data should be compiled in the most detailed manner for the assistance of every refinery employee, as previously stated, this cost variation data should be brought to a focus for the use of the plant and general management. Under a properly designed standard cost plan all cost variation data should be summarized on a single sheet of paper. An illustration of such a focussed statement to meet the requirements of the management of a refinery operating under usually complex conditions and ramifications is shown in Figure 1. With this form the plant superintendent can see at a glance exactly what his situation is as regards operating efficiency. Such a statement gives him the bird's eye view—the perspective so necessary to an executive. It shows him the relative importance of cost variations—he naturally picks out the larger red items and for such items as he selects subsidiary statements giving him the finest detail.

Standard costs are not expensive to operate—in over 20 years' experience in introducnig standard costs the writer can recall no case where it was necessary to add a single clerk when any kind of adequate cost plan was previously in operation. They do not interfere with the general accounting except to ensure more accurate data being furnished to the general accountants. And the writer has yet to hear of any properly designed and installed standard cost system being abandoned.

The standard cost methods which work admirably in manufacturing plants in general cannot be applied in the oil refining industry without extensive modifications to meet the particular complexities of oil refining. It is in large measure due to the inapplicability in oil refining of standard costs as used in other industries that an impression has been created that standard costs cannot be applied to oil refining. As a matter of fact, the more complex the operations of a business, the more necessary are standard costs to a management wishing to control those operations, and this applies with particular force to the oil refining industry.

To introduce standard costs successfully in an oil refinery requires the cooperation of both the operating and the accounting departments—for either of these to attempt to install standard costs without the strong support of the other would probably result in failure. In view of the technicalities of standard cost accounting and the necessity for experience in this specialized branch of work, the only really satisfactory way in which to introduce a standard cost system is through the cooperation of three agencies: (1) the operating division, which contributes technical refining experience and furnishes the basic data on which the standards are set; (2) the accounting division which works with the operating division in setting the standards and which installs and operates the system, and (3) the expert professional standard cost technician who, working with both the operating and accounting organizations, designs the working plans. Under such a program a standard cost system cannot fail to prove a magnificent investment.

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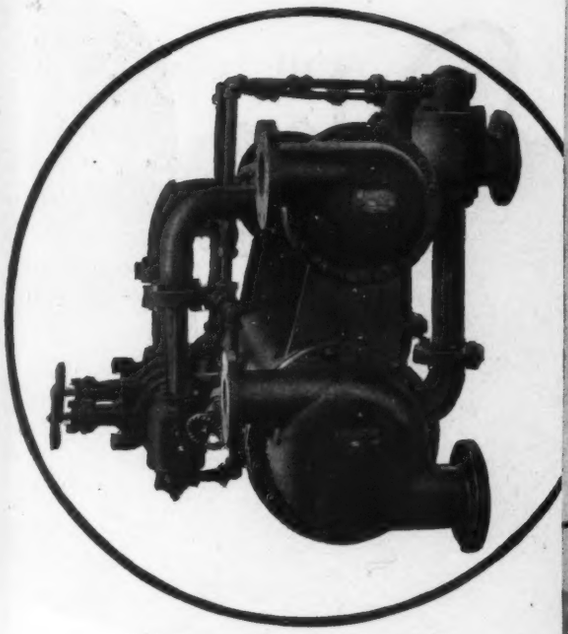

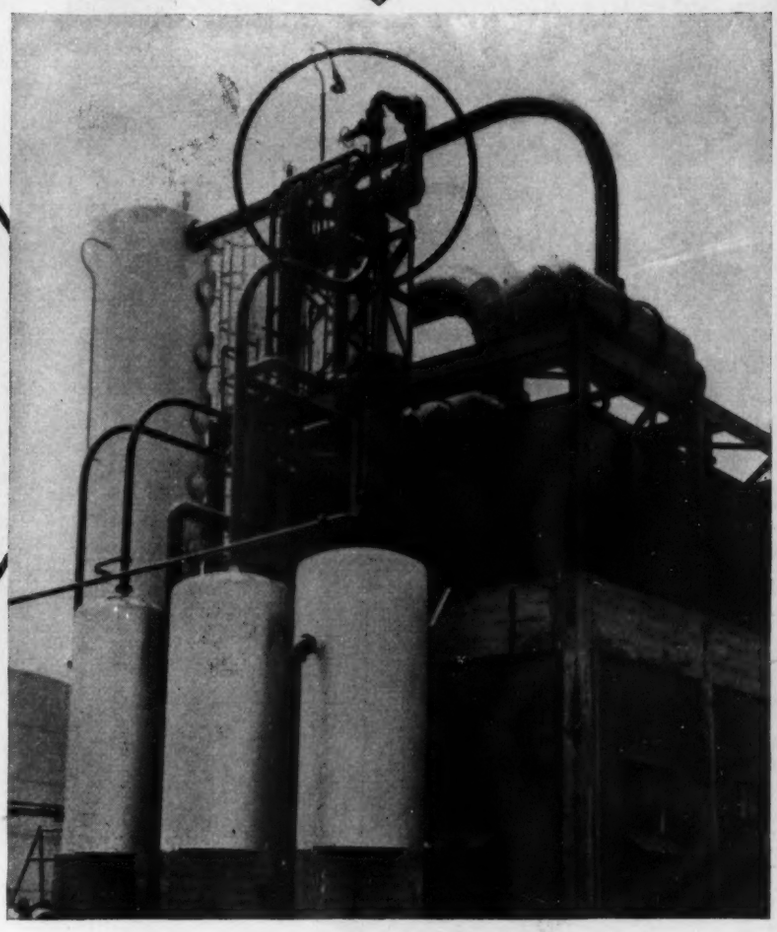

Above: Elliott two-stage ejector of a type similar to that used in the installation at the right. Elliott ejectors are built in all types and sizes.

At right: Elliott two-stage ejectors serve both the dry vacuum and wet vacuum towers of a very efficient three-column pressure distillate rerun unit. Exhaust from the ejectors supplies the small quantity of stripping steam required.

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PIONEERS IN THE DESIGN, CONSTRUCTION AND APPLICATION OF STEAM JET EJECTORS.

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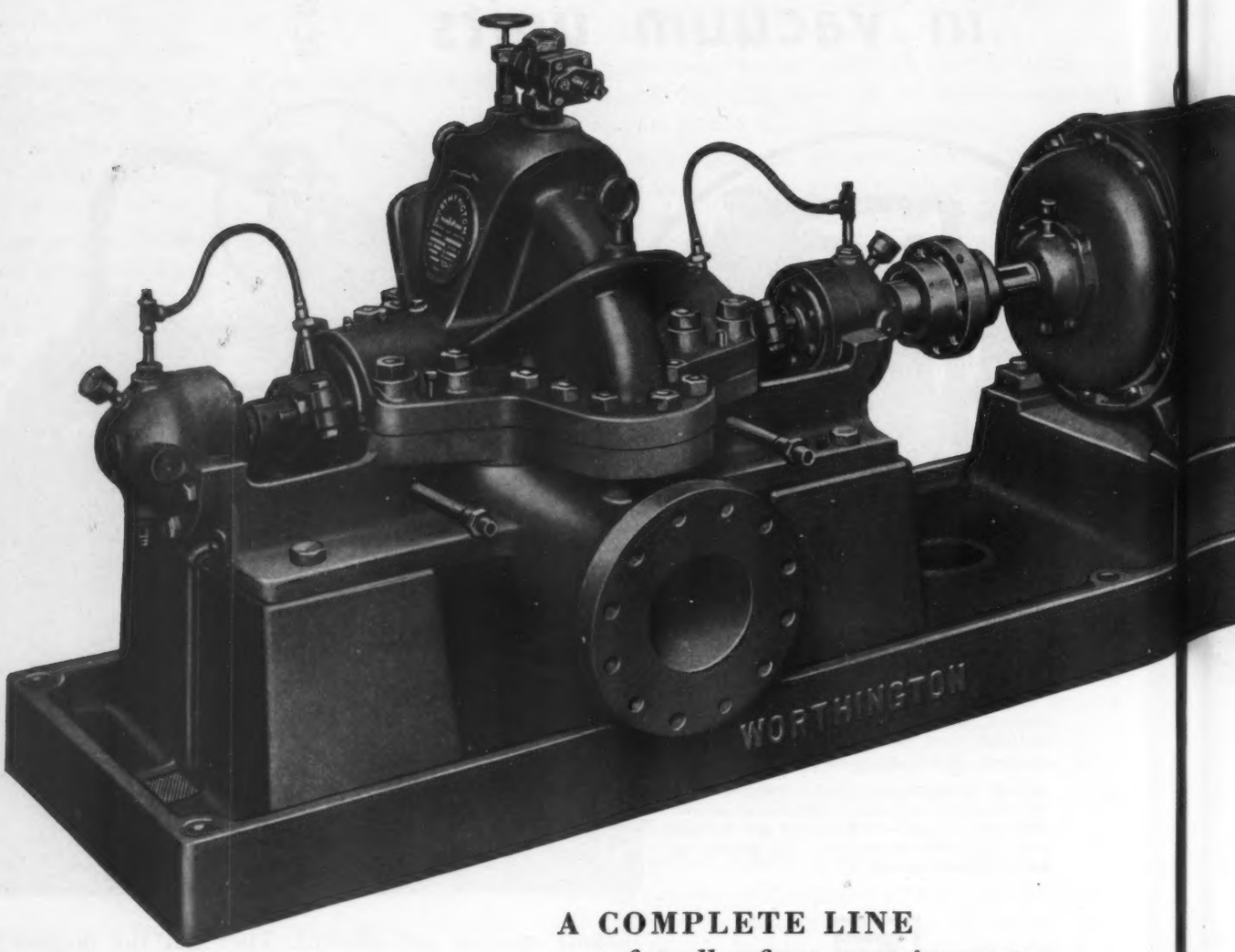

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SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

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by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles apppearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical Data

Vapor-Liquid Equilibria of Hydrocarbon Mixtures. E. C. BROMLEY *and* D. QUIGGLE. *Ind. Eng. Chem.* **25** (1933) pp. 1136-38.

Data are given covering the vapor-liquid equilibria for the system n-heptane—toluene, toluene—n-octane, 2, 2, 4-trimethyl pentane (iso-octane)—n-octane, and n-heptane—methyl-cyclohexane. Two ternary systems were also studied, namely n-heptane—methyl-cyclohexane—toluene, and n-heptane—methyl-cyclohexane—acetane.

Effect of Temperature on the Viscosity of Liquids. E. VAN AUBEL. *Bull. Sci. Acad. Roy. Belg.* **18** (1932) pp. 1026-47.

The experimental facts regarding the effect of temperature on viscosity of organic liquids, liquids above their boiling point, aqueous solutions and molten salts are best represented by van Aubel's equation, $\phi = m + n \log (\Theta - t)$, where ϕ is the fluidity, t the temperature, Θ the critical temperature, and m and n are constants, rather than by the equation of Andrade ($n = ae^{b/T}$, where T is the absolute temperature, and a and b are constants).

Knocking Characteristics of Naphthene Hydrocarbons. W. S. LOVELL, J. M. CAMPBELL *and* T. A. BOYD. *Ind. Eng. Chem.* **25** (1933) pp. 1107-1110.

An extension of previous valuable works covering the knock characteristics of over fifty paraffin and olefin hydrocarbons of varied structure, is reported. Sixty-nine naphthene hydrocarbons were studied. The measurements of the relative tendencies to knock in an engine were made not on the hydrocarbon alone, but using it in admixture with gasoline. The results are expressed as previously in terms of the anti-knock effect of aniline as the standard. Consistent relationships between structure and tendency to knock was found for the naphthene hydrocarbons. These relationships were, in turn, consistent with those previously found for the paraffins and aliphatic olefin hydrocarbons. For simple compounds the anti-knock value decreases as the ring size increases. Increase in the length of an unbranched side chain results in a decrease in anti-knock value. Position isomerism is of relatively minor importance in relation to anti-knock value. The more branched and compact a side chain the higher the anti-knock value of the compound. Removal of hydrogen from a saturated ring in general increases the aniline equivalent.

Explosions of Mixtures of Hydrogen and Air: The Specific Heats of Steam at High Temperatures. G. B. MAXWELL *and* R. V. WHEELER. *J. C. S.* (1933) pp. 882-885.

Explosion experiments are described in which hydrogen-air mixtures were used. The mean apparent specific heats of steam at constant volume from 15°C. to temperatures approximating 2000°C. were calculated. The authors conclude that they cannot accept recent criticism against this method, i.e., that a loss of energy occurs because of incomplete combustion of hydrogen at the instant of maximum pressure. In their opinion, the values for the mean specific heats of steam as accepted by Partington & Shilling are too low.

The Relation of Carcinogenicity of Mineral Oils to Certain Physical and Chemical Characteristics of these Oils. R. LYTH. *J. Ind. Hyg.* **15**, No. 4 (1933) pp. 226-37.

Refractive indices, densities, iodine values, and permanganate oxidation values are given for the oils studied. The carcinogenic potencies of the oils were determined by experiments with animals. The conclusion was reached that the refractive index of an oil is a good indication of its origin and a probable indication of its carcinogenicity. Oils of refractive index less than 0.5500 were found to be non-toxic, whereas those of refractive index of 0.5600 and higher were highly toxic. Pennsylvania oils and some mildly treated oils were exceptions. The iodine value affords some indication of toxicity provided the oil has not been treated. Permanganate values were not found to be a good criteria of toxicity.

Chemical Compositions and Reactions

Polymerization and Explosive Decomposition of Ethylene under Pressure. G. EGLOFF *and* R. E. SCHADD. *Jour. Inst. Pet. Tech.* **19** (1933) pp. 800-11.

Polymerization of ethylene began between 325° and 340°C. in a stationary autoclave in the presence or absence of alumina under 50 atmospheres initial pressure. Two or three hours heating at 380°C. yielded brown and red oils equivalent to 63-73 percent of the weight of the ethylene charge. Gaseous products formed during the continuous polymerization of ethylene were methane, ethane, propane, normal and iso-butane, normal and iso-pentane, propylene, iso-butene, and butadiene. In the presence of a nickel-alumina-copper oxide catalyst under 49 atmospheres initial pressure ethylene decomposed explosively at 330°, generating 340 atmospheres pressure and producing 40 percent by weight of carbon, and a gas containing approximately 40 percent hydrogen and 55 percent methane.

Catalytic Polymerization of Propylene. F. H. GAYER. *Ind. Eng. Chem.* **25** (1933) pp. 1122-27.

Fuller's earth was found to polymerize propylene at 350°F. and atmospheric pressure. A precipitated porous silica containing alumina adsorbed on its surface had an activity approximately 20 times that of the best activated fuller's earth. The presence of traces of hydrochloric acid increased the activity and life of the catalyst. The polymer product was a liquid of specific gravity 0.7, from which approximately 90 percent was secured by steam distillation as a substantially gum-free highly volatile fuel of octane number 87. The portion boiling up to 150°C. consists of a series of homologous olefins from C_5 to C_9 inclusive. The C_6 fraction was the largest.

The Nitrogen Compounds in Petroleum Distillates. J. R. BAILEY *et al.* *Jour. Am. Chem. Soc.* **55** (1933) pp. 4136-49.

The aromatic and non-aromatic petroleum bases are separated by a procedure called cumulative extraction. This is based on a wide difference in the distribution ratio of the hydrochloride of the two types of bases. The addition of sulphur dioxide has also been applied to the isolation of certain quinolines. Several bases that have been isolated are described.

Catalytic High-Pressure Hydrogenation. A. DROS, A. J. TULLENERS *and* H. I. WATERMAN. *Jour. Inst. Pet. Tech.* **19** (1933) pp. 784-99.

Mesitylene was hydrogenated at 225°C. using a nickel catalyst and an initial hydrogen pressure of 136 kg. per square centimeter. Hexahydromesitylene was formed. Hexamethylbenzene was also hydrogenated. Hydrogenations were also carried out at higher temperatures in order to study destructive hydrogenation.

Quality of Rumanian Petroleum. E. SEVERIN. *Petr. Zeit.* **29** (28) (15.7.33) pp. 13-16.

Petroleum occurs in Rumania in all of the sedimentary formations from the Cretaceous to

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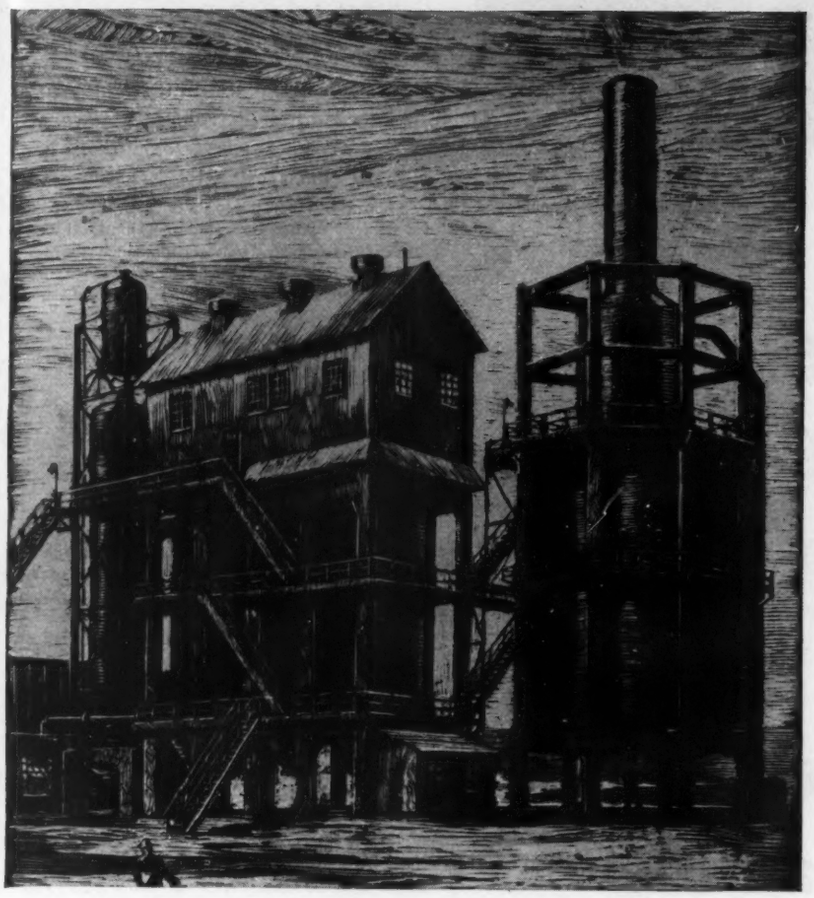

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the early Pliocene. Some crudes contain 30 percent of gasoline, and most of the gasolines contain large proportions of aromatic hydrocarbons and are essentially anti-knock. About 60 percent of the crudes are high gravity and contain paraffin, and 40 percent (gravity 0.845-0.911, 15°C.) are paraffin free. The oils can be classified in four main divisions according to layers and domains. The properties of these oils are given in some detail and are tabulated.

The Conversion of Fatty and Waxy Substances into Petroleum Hydrocarbons. W. F. SEYER. *Jour. Inst. Pet. Tech.* **19** (1933) pp. 773-83.

The author is of the opinion that the origin of petroleum must be sought in material containing long hydrocarbon chains since there is no purely thermal method by which such hydrocarbon chains can be produced. The only sources of such long chains are the fats and the hydrocarbons that are synthesized by vegetable or animal organisms. The conception of energy distribution is applied to a system of organic molecules. The half life period of a material such as hexadecane is calculated for temperatures from 100° C. to 470° C. Considering these data the author concludes that any petroleum containing a large proportion of paraffin hydrocarbons is either a young petroleum or the remains of some material which at no time in its life history passed through a temperature much exceeding 100°C. The maximum depth of oil wells should not exceed 20,000 feet, for at greater depth the temperature would be over 200°C., at which temperature no hydrocarbon material could exist for a long period of time.

Manufacture: Processes and Plant

New Distillation Unit Increases Yield of Lubricating Oils. P. TRUESDELL. *Chem. & Met. Eng.* **40** (1933) pp. 517-19.

The article describes a steam atmospheric distillation unit of the latest design for operating on Pennsylvania grade crude oil. The products produced are of high quality and the yield the best. The design of the pipe still heater is such as to eliminate decomposition of the charging stock. The design of the tower is such as to effect sharp separation of the products.

Contact Equipment for Extraction and Reaction in Two-Phase Liquid Systems. T. G. HUNTER. *Ind. Chemist* **9** (1933) pp. 313-16.

Apparatus for contacting two liquids for reaction or washing purposes is described. The Duriron and Barber jets are illustrated and discussed. Column type contractors considered include the orifice type column, baffle plate and seive plate columns, and column contacting apparatus developed by the Standard Oil Development Company.

Fluid Friction and Its Relation to Heat Transfer. C. M. WHITE. *Trans. Institution of Chemical Engineers* **10** (1932) pp. 66-86.

Paper deals with methods of predicting heat transfer coefficients from fluid friction data. Subject is considered fundamentally and mathematically starting from the basic idea of Reynold's analogy. It is applied to axial flow through tubes, to flow past obstacles, to external flow over the surface of cylinders, and to oval tubes, gilled tubes, and stream-line sections.

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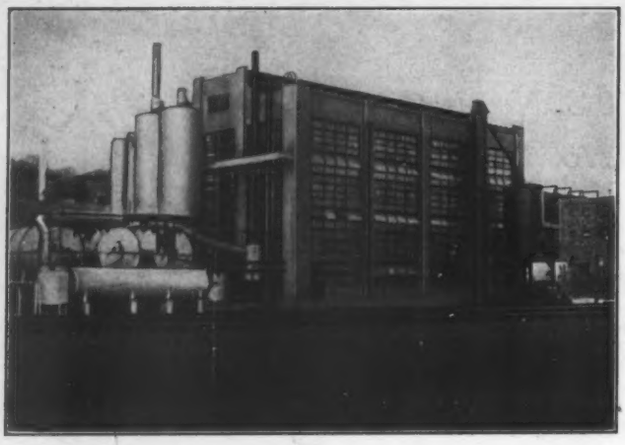

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EPP. *Arch. Warmewirt* **14** (1933) pp. 183-5.

Insulating materials were made of layers of flat aluminum foil 0.002 cm. thick. Heat losses through such insulators were studied. Ten layers separated by 1 cm. each showed practically no radiation and convection loss. The loss by conduction was practically the same as that of air.

Thermal Decomposition of Petroleum at High Pressure. T. KATO. *J. Soc. Chem. Ind., Japan* **36** (1933) pp. 226-227B.

Fractions from Tarakan heavy oil, boiling points 210-300°C., 300-330°C. and 330-360°C., were cracked at pressures between 50 and 300 atmospheres. Losses in terms of carbon deposit and non-condensable gas, increased with increase of pressure and were large at pressures greater than 200 atmospheres, at temperatures above 400°C. Cracking was followed by polymerization, particularly at pressures above 200 atmospheres. The rate of cracking and the yield of gasoline and the iodine number of the gasoline decreased with increase of pressure. The cracked gasoline was not of disagreeable odor.

Clarifying Action of Fuller's Earth. M. E. FOOGLE *and* H. L. OLIN. *Ind. Eng. Chem.* **25** (1933) pp. 1069-73.

The authors are of the opinion that they have proved the inadequacy of the theory of simple adsorption as an explanation of the clarifying action of fuller's earth. A small amount of calcium in the form of a zeolite was found. The conclusion was reached that the action of the earth results in part from adsorption of colloidal matter on the surface of the earth, and in part from a base exchanged between the zeolite and the sol, whereby divalent calcium is liberated from the mineral and ionized, while monovalent peptizing ions are removed from the sol system.

Petroleum Refinery Gas for City Supply. R. S. MCBRIDE. *Chem. & Met. Eng.* **40** (1933) pp. 508-11.

The plant and procedure used in supplying the Brooklyn Union Gas Company with gas from the Brooklyn refinery of the Standard Oil Company of New York is described. Most of the hydrogen sulphide in the gas is removed at the refinery by liquefication. That remaining is left and would be normal to gas-oil enriched gas for which refinery gas has been substituted. The heating value of the gas varies, but averages 1750-1800 B.t.u. per cubic foot. Specific gravity is approximately 1.0. In cold carburetting of blue water gas 1000 cubic feet of refinery gas enriches approximately 6000 cubic feet of blue gas. When too much refinery gas is available, it is resorbed to a lower heating value. When too little is available blue gas is lightly carburetted with oil.

Products: Properties and Utilization

Antioxidants (for Oils). T. YAMADA. *J. Soc. Chem. Ind., Japan,* **36** (1933) pp. 176-177B.

α- and β-naphthols, α-naphthylamine, and p-amino-phenol absorb oxygen with an induction period similarly to oils. Quinol is exceptional in this respect. The addition of oil to α- or β-naphthol accelerates the absorption of oxygen. The antioxidant activity is almost destroyed if a copper strip is immersed in an oil, provided the concentration of the antioxidant is less than a certain value, and is low if the concentration is above this value. Oils that

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contain large proportions of peroxides when treated with α-naphthol absorb oxygen more quickly after a short induction period. Antioxidants, excepting quinol, reduce peroxides slowly.

Turbine Oils and Their Qualities. BOHNENBLUST. *Compt. rend. congr. graissage* (*Strassbourg*) (1931) pp. 393-42; *Chimie & Industrie* **29** p. 567.

The Brown Boveri Company subjects turbine oils to the following tests: (1) Artificial aging by heating three days at 110°C. in a beaker in the presence of a copper plate (40 x 70 x 1 mm.). The plate is polished with chalk of specified fineness. At the conclusion of the three day period the oil is filtered and the deposit washed with gasoline. (2) The emulsification test effected by introducing a jet of steam under one atmosphere of pressure 2 mm. above the bottom of a graduated tube held in a steam bath and containing 50 cc. of water, 50 cc. of oil, and a few cc. of one percent NaOH. After emulsification the nature of the surfaces of separation between the water emulsion and oil layers are plotted as a function of time. It is claimed that after some experience valuable indications are thus obtained regarding the tendency of degradation of the oil.

The Viscosity-Dilution Function of Lubricating Oils. J. TAUSZ *and* A. RABL. *Petroleum Z.* **29**, No. 24 (1933) pp. 1-3.

The values of x_{10} and x_{20} for oils in 10 percent and 20 percent solution in toluene distinguish three classes of oils; (1) fatty oils, 0.805-0.850, 0.65-0.675; (2) oils rich in hydrogen (such as paraffins and naphthenes) 0.680-0.722, 0.470-0.529; (3) and oils poor in hydrogen (aromatic compounds) 0.599-0.632, 0.3440-0.402. For oils of high viscosity and for diluents of viscosity close to 1.0, the value of "n" in the Lederer equation is almost the same as that of "x." The author believes that the number of equations relating the variation of viscosity to dilution, temperature, and pressure should be reduced. Several of these can be changed to the form, $n_c = n_0 e^{acf(c)}$, where c is concentrate (or temperature or pressure), n_0 is the viscosity of the undiluted oil (or at standard temperature or pressure), and a is a constant.

Physico-Chemical Researches on Acidity of Aged Mineral Oils. E. VELLINGER *and* A. KLINKENBERG, *Ann. des Comb. Liq.* **8** (1933) pp. 301-312.

Because of the dark color the usual methods for determining the acidity of aged oils are difficult. The authors use the antimony electrode and titrate potentiometrically in alcohol-ether adding lithium chloride. Neutralization curves are given for oils not highly refined both in the presence of deposit and free from deposit. Oils that have been highly refined show a much higher percentage of acid on oxidation. The less refined oils show a correspondingly larger deposition of sludge. The greater the sludge the less the acidity, and vice versa.

Durability of Oil-Films. J. TAUSZ *and* P. SZEKELY, *Erdol u. Teer* **9** (1933) pp. 331-332.

The thickness of oil films between metal surfaces are measured with difficulty because of the impossibility of obtaining perfectly plane metal surfaces. The use of mercury instead of one of the metal plates avoids this difficulty. The apparatus used comprises a 2 cm. diameter steel ball immersed 0.8 cm. in a bath of mercury. A drop of oil is placed on the surface of the mercury before immersing the ball. Hydrostatic pressure tends to form a thin film of oil around the ball and viscosity tends to keep the oil in position. The thickness of the oil film is measured electrically by means of a

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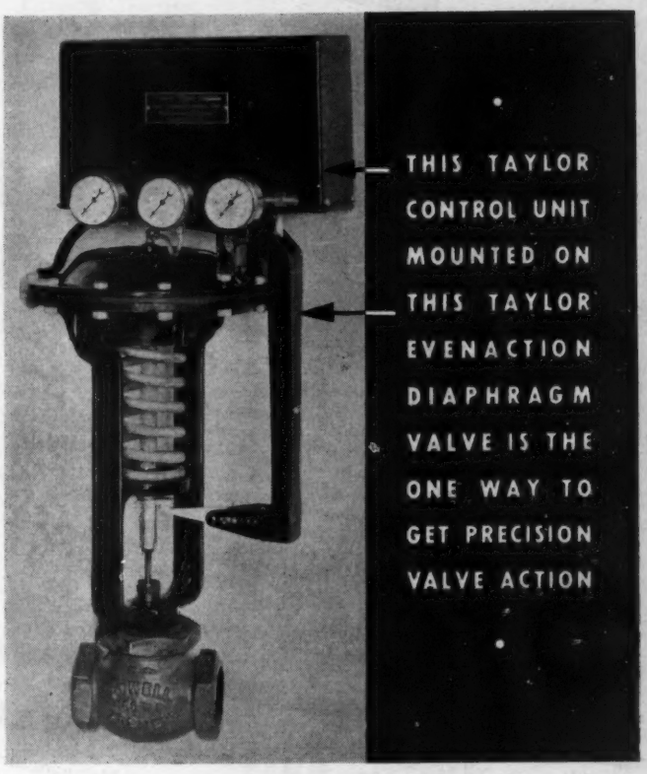

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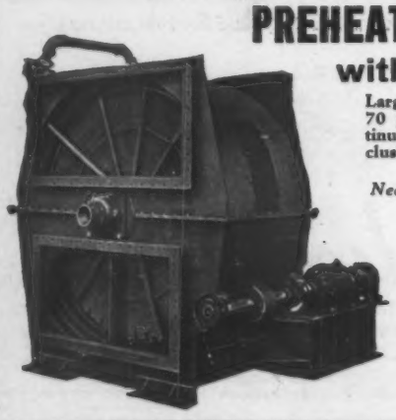

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capacity bridge, the ball and the mercury forming the plates of the condenser and the oil the dielectric. Many oils were examined in this manner and the viscosity resistance after a given time and film thickness attained were recorded in tabular form. Aromatic-base oils were the only ones showing a break-down of the film in times under 22 hours. Naphthene-base oils were stable, even gas-oil having a film thickness of 0.029μ, and ruptured only after 1560 hours. As a matter of comparison, an aromatic gas-oil of twice the viscosity broke down in a few minutes. A cylinder oil had a thickness of 0.4μ after 195 hours without rupture. Castor oil showed a film of 0.115μ film thickness after 918 hours without rupture.

"Four-Ball" Testing Apparatus for Extreme-Pressure Lubricants. G. D. BOERLAGE. *Engineering* **136**, (1933) p. 46.

The "four-ball" apparatus is simple and easy to manipulate. A weighted belt-driven vertical shaft having a cup-shaped lower end rotates on a ½ inch diameter ball bearing. This ball rests on three others arranged in the form of a pyramid. The three balls are held tightly together by a conical ring and to the bottom of a cup which retains the oil under test as well as the balls. The upper ball, therefore, has three points of contact. The shaft is rotated. The friction of the balls tends to rotate the oil-containing cup which rests on a table supported on ball bearings. The torque on this table is measured by a spring dynamometer. Most easily secured results are obtained by determining at a given speed the highest pressure that an oil will stand for a period of one minute without permitting the balls to seize. The best mineral and fatty oils will not stand an applied force of 150 kg., whereas extreme pressure lubricants will easily stand 300 kg., and a few specially prepared stands have withstood 800 kg. Extreme pressure lubricants are remarkable for they prevent seizure of the balls under pressures that are higher than the balls would stand mechanically without permanent deformation.

Preparation and Use of Bituminous Paints. ANON. *Revue des Produits Chimiques* **36** (1933) pp. 193-198; *Oil & Colour Trades J.* **83** (1933) p. 1533.

The materials used in the preparation of asphaltic paints include asphaltites such as gilsonite, natural asphalts, and petroleum asphalts as such, or blown or sulphurised. Blown bitumen is elastic, little susceptible to temperature change, and resistant to vibration and cold. It is used in high quality enamels for pipes and stacks. Asphalts vary markedly as to opacity and coloring capacity, the harder and more brittle materials having greater density and darker color. The dense asphalts do not dissolve as readily in turpentine and naphtha. Varnish asphalts should not, therefore, be too hard. It is usually necessary to blend several asphalts to obtain the desired properties. Experience is essential for surprising results may be had owing to the interaction of the components of the mixture. Although the aromatic hydrocarbons are good solvents they are not much used because of their poisonous character. The flexibility of a paint film is increased by the addition of wool grease, tallow, stearine, or pitch. The adhesivity is also increased. Linseed and tung oils may be added, but mineral oils are not satisfactory. Bituminous paints are divided into three classes: (1) Varnishes, comprising asphalts in volatile solvents; (2) varnishes containing linseed oil or other oil as well as solvents; (3) varnishes containing asphalt rosins and gums.

THE MONTH IN REVIEW

A. P. I. Mid-Year Meeting in Pittsburgh

MID-YEAR sessions of the American Petroleum Institute and its three divisions—refining, production and marketing—will be held at the William Penn Hotel in Pittsburgh, May 22, 23 and 24. Selection of Pittsburgh for the mid-year meeting in 1934 allots the two important assemblies of the Institute to different sections of the country. The annual meeting will be held in Dallas, November 12, 13, 14 and 15. With several hundred committees at work on technical and practical problems of operation in connection with producing, refining, transportation, and distribution of petroleum products, the mid-year meetings for committee work have grown increasingly important. Great progress has been made in these meetings in furthering programs of standardization and in effecting economies of operation for the industry in the fields of engineering and technology. In addition to the three divisional meetings at Pittsburgh, the American Petroleum Industries Committee will be in session and Baird H. Markham, director of the A.P.I.C. will hold conferences with state petroleum industries committees.

A. S. T. M. Leases New Headquarters

THE executive committee of the American Society for Testing Materials has leased new headquarters in Philadelphia in the Atlantic Building at Broad and Spruce Streets, and will be occupied about the first of January. The present address is 1315 Spruce Street. The new offices contain about 1350 square feet of floor space on the fourth and fifth floors of the building, owned by The Atlantic Refining Company; the lease is for five years.

58 Year Old Still On Its Last Run

PENNSYLVANIA Refining Company, with refineries at Karns City and Titusville, Pennsylvania, has been modernizing its refineries this year. At the Titusville plant, where Adam Mosher is superintendent, the company is completing installation of a new distillation unit of modern design, consisting of tube still furnace and fractionating equipment (Arthur G. McKee & Company contract). The new distillation facilities were erected on the site of the first distillation equipment used at this refinery. On October 10 when the accompanying photograph was taken the last of the two old cheese box stills was still standing—and still in operation after 58 years of service. The new and modern equipment should go into regular service this month. At the time the photograph was taken the old cheese box was making its last run and heading for the junk-heap. Incidentally, not many more such still batteries are now in existence, and few, if any, in operation.

Gas Engines as Prime Movers for Pumps

THERE were certain technical problems to be solved, and certain prejudices to be overcome before the refining industry could give serious thought to the proposal that gas engines be used as prime movers for cracking unit charging and hot oil pumps. The technical obstacles which appeared in conjunction with the use of refinery gas as fuel have been overcome, and refinery gas, washed free of hydrogen sulphide is serving admirably as gas engine fuel at five refineries where such engines are driving large pumps. The prejudices have for the most part been cleared away—and now use of such equipment is, or should be, merely a matter of economics. Steam, electricity, Diesel engines, turbines, all have their place.

In the matter of gas engines as prime movers, however, the pioneer work was done by Imperial Oil, Ltd., at its Sarnia, Ontario, Canada, plant, early in 1929, when the engineers for the refining company and engineers for National Transit Pump and Machine Company got together and decided that it was a good course to follow. In July 1929 the first twin engine was installed to handle the hot oil pump in connection with a Tube and Tank cracking unit. In February of 1930 two more twin gas engines were shipped to Sarnia, and in March 1930 a twin Transit went to the Halifax plant—all to serve as prime movers for hot oil pumps.

During this period and prior to the installation of Dubbs unit No. 3 at the Pennzoil plant, Oil City, L. D. Fulton, general superintendent for Pennzoil Refining Company was giving the matter of gas engine drives much thought and making quite a few trips to Sarnia to give that installation his personal study. His argument was "why not make these cracking units self contained, make them use their own gas as fuel and for pumping purposes and eliminate the necessity of further enlargement of the steam generating plant?" The upshot of his consideration was that cracking unit No. 3, in March 1931, had two gas engine driven pumps, one for charging and one for handling hot oil.

With the advent of Dubbs cracking unit No. 4, which perhaps, is the only Dubbs unit erected without and operated without a reaction chamber, Mr. Fulton was sufficiently well pleased with gas engine drive to specify two more National Transit gas engine

This still at Pennsylvania Refining Company's plant at Titusville is going out of service after 58 years.

driven pumping units, and in November 1932 these units were installed in a control room adjoining the pump room of cracking unit No. 3, where their predecessors were (and are) still efficiently doing their job. This installation is described in detail elsewhere in this issue of The Refiner.

When the Tide Water Oil Company installed its new Tube and Tank cracking coil at Bayonne, New Jersey, early in 1932, the design included crank and flywheel duplex type hot oil charging pumps, connected through reducing gears to simplex, double acting, tandem gas engines, using refinery gas as fuel. These units were built by Worthington Pump & Machinery Corporation. (This installation was described in detail in The Refiner, issue of October, 1932, page 502.)

The next gas engine driven pump installation was installed at the Bristow, Oklahoma, refinery of Marathon Oil Company, where a National Transit gas engine driven hot oil pump is used to charge hot oil to the viscosity breaking furnace of the Kellogg combination cracking unit. This recently completed cracking system is described elsewhere in this issue.

The performance records of these installations have done much to arouse interest in gas engine drives, and future construction will no doubt see more of them in service, especially where study of economic factors points to the advisability of utilization of such equipment.

Midwestern Chemists to Meet at Kansas City

THE twelfth midwest regional meeting of the American Chemical Society will be held in Kansas City, May 3, 4 and 5. Arrangements are being made for a group of papers relating to the petroleum industry as a part of the program. Dr. Roy Cross of the Kansas City Testing Laboratory is chairman of the petroleum group and H. M. Steininger of Standard Oil Company (Indiana), Sugar Creek, Missouri, is its secretary.

Mr. Steininger has requested that anyone having a paper for consideration get in touch with him through the Kansas City office, 700 Baltimore Avenue, Kansas City.

Stillman Had Long Career in Refining

C. O. STILLMAN, former president of Imperial Oil, Limited, died in Toronto, Canada, on November 18, after a brief illness. When he retired in June last from the presidency of Imperial Oil, after holding that office for 14 years, Mr. Stillman had completed more than 52 years in the oil industry.

He was born at Cleveland, Ohio, in 1864, and at the age of 16 went to work under his father at the Standard Oil Company plant at Bayonne, New Jersey. He served for two years in that plant and for the next eight years was occupied in various departments. In 1890 he was appointed superintendent of the Atlas plant at Buffalo, New York, and in 1896 was sent to Petrolia, Canada, to manage the Bushnell Company which had been acquired by Standard interests. In 1897 he began construction of Imperial Oil's first refinery at Sarnia. He was appointed a director and superintendent of Imperial Oil in 1899 and general superintendent in 1901. He became assistant general manager in 1910 and vice president the following year. In April 1919 he succeeded the late W. J. Hanna as president.

Until last June he was a director of International Petroleum Company, Limited, and at the time of his death was a director of Dominion Bank of

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Canada and of Canadian General Securities. He is survived by his widow. The funeral was from his late home in Toronto on November 20 and interment was at New Dorp, Staten Island, New York.

DR. B. H. LINCOLN

Lincoln Promoted to Continental Chief Chemist

DR. B. H. LINCOLN, assistant to the manufacturing manager of Continental Oil Company, has been named chief chemist for the company and will maintain headquarters in Ponca City. His promotion follows the recent death of Alfred Henrickson, former chief chemist. Lincoln graduated from the University of Arkansas, Bachelor of Science degree, in 1932, majoring in chemistry. He spent 3½ years at the University of Colorado majoring in organic chemistry, securing his doctor's degree. During this period he acted as an instructor in both inorganic and organic chemistry.

In the summer of 1925 he organized and equipped a sanitary engineering laboratory for the State of Colorado and operated it for two months. From July, 1926, until July, 1929, he was chief research chemist for Continental Oil Company of Maine. In July, 1929, following merger of Continental Oil Company and Marland Oil Company to form Continental Oil Company of Delaware, he became assistant to the manufacturing manager of the new organization. Since 1929 Lincoln has studied law, specializing in patent law, and in August, 1933, he was admitted to the United States patent office bar.

ROBERT W. BLACK, chief safety engineer for Standard Oil Company of New Jersey, was recently elected general chairman of the Petroleum Section of the National Safety Council. Mr. Black has been with the Standard organization since 1920, starting in the general engineering department at Bayonne, to later work in inspection of fire and safety equipment at the plants of the New Jersey and and Louisiana Standard companies. He has been chief safety engineer for Standard Oil Company of New Jersey since 1930.

W. W. ROBINSON, JR., formerly director of gas research with the Texas Company and working in the Beacon, New York, laboratory, has been named chief chemist for the gasoline division of The Texas Company of California and is again stationed at Long Beach.

J. R. McKINNON, assistant superintendent for Spartan Refining Company, Shreveport, Louisiana, where a large Gyro cracking installation is now under construction, has been spending the past several weeks studying Gyro opera-

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tion at The Pure Oil Company's Toledo, Ohio, plant, and has recently gone to Muskogee, Oklahoma, for further study there.

L. L. REBBER, MacMillan Petroleum Corporation, El Dorado, Arkansas, read a paper on "Lubricating Oils" before the November meeting of the technical group of the Louisiana-Arkansas Refiners Association, at El Dorado. Over 200 representatives of eight refining companies were in attendance.

JACK VAUGHN, for several years a petroleum engineer for Gulf Production Company, Houston, has resigned to organize a company to operate in East Texas and to erect a natural gasoline plant.

C. H. HAUPT, vice president and chief engineer, Standard Oil Development Company (Standard Oil Company of New Jersey subsidiary) is retiring from active duties after a period of service with the company extending over 33 years.

DR. G. G. BROWN, University of Michigan, addressed the Chicago section, American Chemical Society at the Midland Club, Chicago, November 24, on the subject "Combustion of Gasoline in Automobiles."

E. M. GOOCH, Pure Oil Company, formerly stationed at Toledo, Ohio, has been transferred to the company's Smith's Bluff (Nederland) Texas refinery in the position of resident chemist.

L. S. CANNON, formerly chief research chemist, Continental Oil Company, has been made general control chemist for the company and will have headquarters in Ponca City.

J. S. HUME, formerly assistant chief chemist, has been appointed resident chemist, a newly created position, for Continental Oil Company at its Ponca City refinery.

R. W. McNAMEE is now with Carbide and Carbon Chemicals Corporation at the South Charleston, West Virginia works.

E. C. CRITTENDEN, chief of the Division of Electricity of the United States Bureau of Standards, has been appointed assistant director of the bureau in charge of research and testing, to fill the vacancy created by the appointment of L. J. Briggs to the directorship of the bureau. Mr. Crittenden has been in service at the Bureau since July 1, 1909.

LUDWIG SCHMIDT, petroleum engineer, United States Bureau of Mines, Bartlesville, Oklahoma, station is reported recovering at his Bartlesville home following serious injuries received in an automobile accident near Niles City, Michigan, in October.

M. E. GARRISON, gas engineer for General Petroleum Corporation, before the November meeting of the California Natural Gasoline Association, in Los Angeles, presented a paper "Fundamentals of Absorption and Distillation."

Book on Oil Analysis

"ANALYSIS of Oil for the Production of Lubricants," by Arthur A. Ashworth, is an attempt at standardization of the analysis of crude petroleum to estimate maximum yield of lubricating oil fractions. The 63-page book, with seven drawings, describes in detail the installation and operation of a small laboratory or pilot

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pipe still, a vacuum distillation assembly, the treating equipment and the methods of test for viscosity and a few other physical properties of finished distillates. The book will prove of some value to chemists interested in the design or operation of laboratory equipment for distillation work.

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THOSE interested in formulas of various materials will find the new first edition of The Chemical Formulary of real interest. The comprehensive work is a condensed collection of valuable, timely, practical formulas for making thousands of products in all fields of industry. It will prove of value to chemists, engineers, technical workers, purchasing agents, executives, instructors and others who often have need for such information. Over forty industrial chemists, professors, and technicians in many fields and branches of industry have cooperated to make this most modern work available.

The Formulary is divided into 40 sections, alphabetically arranged in the subject index, and is provided with a complete detailed index of all items for which formulas are given, which likewise is alphabetically arranged. The two indexes make the book easy to use as a reference. It can be secured from The Chemical Formulary Company, Bush Terminal Bldg. No. 5, 950 Third Ave., Brooklyn, New York. Price $6.00.

New Book on Stainless Steels

THE American Society for Steel Treating has recently published "The Book of Stainless Steels" which is designed to fill a need in the literature of metallurgy, as there has been no book describing American usage and practice. Seventy-seven authorities on the manufacture and utilization of the many kinds of heat and corrosion resisting chromium alloys have collaborated to write this 614-page book, under the editorship of Ernest E. Thum, editor of Metal Progress. Each contributor was selected to prepare a chapter for the book on his particular specialty in the field. The text is authoritative, and because of the evident careful planning and editing, it resolves itself into a logical and consecutive compendium of practical information with the emphasis on the uses of the various type of stainless steels. About two thirds of the chapters describe the properties of the steels—how to fabricate them and what to expect of them in various services. Others deal with a large number of successful applications described by men in the consuming industries who are intimately familiar with these applications. Two of the chapters will be found to be of special interest and value to petroleum engineers.

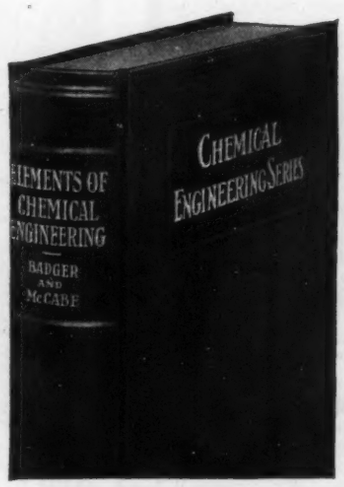
Due to the ever widening field of use for stainless steels, the new book should be of real value in many industries. It is prepared so that the reader need not be a highly trained technologist to profit from it, but even the most demanding technical man will find plenty of precise information. "The Book of Stainless Steels" has 614 pages of text, 200 illustrations, including photographs, charts and diagrams. It is bound in red cloth, is 6 x 9 inches, and the price is $5.00 and may be secured through the Gulf Publishing Company, 3301 Buffalo Drive, Houston, Texas.

Petroleum Encyclopedia

"A COMPREHENSIVE encyclopedia of Pure and Applied Chemistry of Petroleum" will be prepared under the editorship of Dr. A. E. Dunstan, Dr. A. W. Nash, and H. T. Tizard, and published by Oxford University Press. They will have the valuable assistance of a board of advisers consisting of distinguished experts from several countries. It is expected that the encyclopedia will be published in 1935.

The contributions will be arranged in a number of sections which will include the following headings: General Chemistry of Petroleum; Refining Processes, Physical; Refining Processes, Chemical; Cracking; Hydrogenation; Corrosion in the Petroleum Industry; Syntheses from Petroleum Derivatives; Colloid Chemistry and Physics of Petroleum; Prevention of Losses; Construction Materials; Utilization of Gaseous Hydrocarbons; Primary Products of Petroleum and Their Applications; Shale Oils and Tar Oils; Fuel for the Internal Combustion Engine; and Detonation.

Each section will be prefaced by an introduction reviewing the principles of its subject in a style suitable to the general petroleum technologist, so that everyone, whatever branch of the industry with which he is concerned, will be able to see the important points. The introduction will be followed by specialist articles of advance technical standard, to which experts in the subject may refer with confidence.



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Manufacture of Greases

SOME interesting data is presented in Bureau of Census final report for 1931 dealing with Petroleum Refining and Lubricating Oils and Greases Not Made in Petroleum Refineries. At the end of that year there were 33 plants engaged in the production of petroleum with a total production for 1931 of 16,958,628 gallons. There were 43 plants in the industry making lubricating greases, producing 27,283,804 gallons. There were 19 plants making axle grease, reporting a total of 1,575,899 gallons, or a total of 28,857,703 gallons of grease valued at that time at $10,153,427.

Outside of the industry there were reported 177 establishments making lubricating greases. Thus, greases not made in petroleum refineries and coming from this group, totaled 25,364,999 gallons with a total valuation at the end of 1931 of $11,132,890.

Overall production of greases, including 1,393,963 gallons coming from "other industries" for 1931 amounted to 55,616,665 gallons, valued then at $22,266,187.

The lubricating oil content of greases made outside of refineries, that in greases from "other industries" as well as that made by refineries, must, naturally come from the crudes refined in this country having lubricating oil fractions. About once every two years when the Bureau of Census publishes its data the industry is reminded that it produces in its own plants but slightly more than half of the total lubricating greases used in this country.

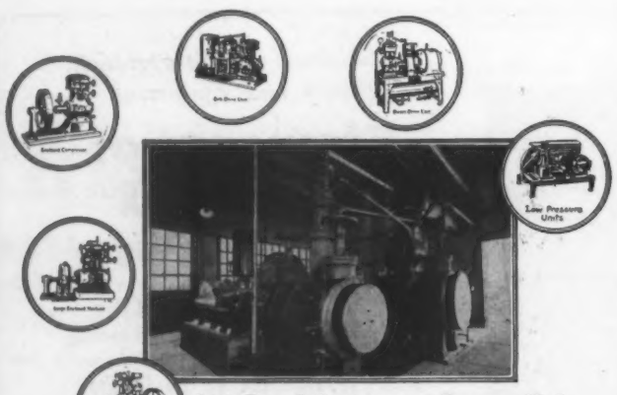
Technical Paper on Viscosity of Natural Gas

SINCE viscosity is an important factor in solving many engineering problems requiring the application of theories and laws of fluid movement that confront the petroleum and natural gas industries, the Bureau of Mines has issued a technical paper in which is described an apparatus and method for determining the viscosity of natural gas.

Until recently viscosity has been accorded relatively little weight in the solution of natural gas problems, and few pertaining data have been published. However, research has shown that it is frequently desirable and often necessary to have a numerical value for the viscosity of the gas under consideration.

The theoretical and mathematical treatment of the subject of gas viscosity and the laws governing its behavior are exceedingly complete, especially for natural gas. Accordingly, after giving reference to the available literature on the theory of liquid and gas viscosity, the authors, W. B. Berwald, and T. W. Johnson, in clear and nontechnical language, have given a brief discussion on the viscosity of fluids; to show from the data of previous experimenters that the same general laws of fluid motion apply to an analysis of the flow of either liquids or gases; and to develop a method from these general laws of fluid motion for measuring the viscosity of the natural gases sufficiently accurate and practical for use in natural gas engineering work.

The data developed by Berwald and Johnson pertaining to the viscosity of pure gases and gas mixtures (including 25 natural gases) and the effect of temperature and pressure on gas viscosities, have been presented in convenient tables and charts. In addition, the application of viscosity data to analysis of some gas engineering problems is shown. Copies of Bureau of Mines Technical Paper, 555, "Viscosity of Natural Gas" can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.



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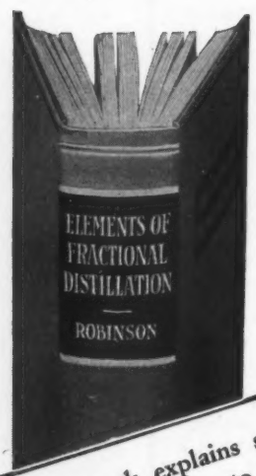

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PLANT ACTIVITIES

Enlarge: Shamrock Oil & Gas Company, Lefors, Texas, is revamping and enlarging its natural gasoline plant in Section 50, Block 25, I. & G. N. Survey, Clayton lease, from 15,000,000 to 75,000,000 cubic feet daily by adding absorbers and distillation facilities.

Refinery: Security Petroleum Company, Chase, Kansas, has secured site for a refinery near the Chase townsite pool, Rice County, Kansas, just south of the city limits. Construction to start at once.

Operating: Allegheny Refineries, Inc., Bolivar, New York, has completed construction work and plant was to start operating during the first week of December. Leader Industries, Inc., contract.

Catalytic Process: Houdry Process Corporation, Paulsboro, New Jersey, is building a 2000-barrel unit of the Houdry process, a low pressure catalytic process for production of high octane value motor fuels.

Gasoline Plant: Henagan & Hanlon, Inc., Tulsa, and Sisterville, West Virginia, are building a 5,000,000 cubic foot natural gasoline plant on the Dye Farm, Richey County, West Virginia, to process gas from the Lost Run pool. Gasoline will be run to the company's central stabilizing and treating plant at Cornwallis, West Virginia.

Gasoline Plant: Humble Oil & Refining Company, Conroe, Montgomery County, Texas, completing erection of a 12,000,000 cubic foot combination compression-absorption natural gasoline plant. Much of the material moved from the Company's Yates field, Texas, gasoline plant.

Cracking Unit: Danciger Oil & Refining Company, operating skimming plant at Bodie Switch, near Longview, East Texas field, is reported preparing for construction of cracking or reforming unit.

Gasoline Plant: Danciger Oil & Refining Company, Pledger, Brazoria County, Texas, is erecting a small absorption gasoline plant to handle gas from two producing wells in the new company controlled field.

Gasoline Plant: The Texas Company, Crowell, Foard County, Texas, erecting a gas processing plant to process gas from the company's L. K. Johnson lease. J. L. McMahon, Division manager. Capacity, 10,000,000, to operate February 1, 1934.

Rebuilding: New Mexico Road Oil Company, Dayton, New Mexico, plants rebuilding road oil plant recently destroyed by fire. Process crude from the Getty pool.

Refinery: Economy Oils, Ltd., Calgary, Alberta, Canada, following purchase of Economy Oil Company, same city, announced plans for erection of refinery in Calgary.

Enlarge: Midland Gasoline Corporation, Conroe, Texas, field, has completed additions to its gasoline plant, doubling capacity. New absorption and distillation systems included; designed by Petroleum Engineering, Inc., associated with Arthur G. McKee & Company.

Improvements: Associated Oil Company, San Francisco, announced recently that an additional $1,000,000 will be spent immediately on plant improvement. This in addition to $6,000,000 improvement program announced early this year and now virtually completed.

Purchase: Petroleum Specialties Corporation has purchased the old Carbo refinery at Guthrie, Oklahoma, and is reconditioning. L. Grigsby, superintendent.

Gasoline Plant: Clymore Company, headed by Garland Clymore, plans construction of a 30,000,000 cubic foot natural gasoline plant in the Agua Dulce field, near Banquette, Nueces County, Texas. A 500-barrel skimming plant is also planned and reports state a carbon black plant may follow.

Gasoline Plant: O. C. Field Gasoline Company let contract to Fluor Corporation for construction of absorption natural gasoline plant at Huntington Beach; capacity 30,000,000 cubic feet; to be in operation about January 1.

Refinery: Wentworth Refineries, Ltd., Burlington Street, Hamilton, Ontario, Canada, reported asking bids for refinery equipment including stills, storage tanks, centrifugal pumps, boilers, etc., for proposed new refinery.

Enlargement: White Petroleum & Refining Company, R. F. D. 4, Cambridge Springs, Pennsylvania, plans to enlarge its refinery at Hickory Town Road, Allegheny Townsite, Venango County.

Gasoline Plant: Excelsior Refining Company, Inc., Henderson, East Texas field, has sold part interest to H. L. Hunt Production Company, and plant capacity will be enlarged to take care of gas produced by the latter.

Correction: Gregg-Tex Gasoline Corporation, Longview, Texas, now operating, is having the output marketed by Hanlon-Buchanan, Inc., Tulsa, and not by the non-existent Brooks-Hanlon Gasoline Company, as erroneously stated in these columns in October.

Cracking Unit: Southport Petroleum Company, Kilgore, East Texas field, let contract to Mid-Continent Engineering Company for erection of a 1500-barrel Donnelly cracking unit. Southport operates skimming plant under name of Hiotane Refining Company.

Operating: Sloan & Zook Refining Company, Warren, Pennsylvania, has completed erection of a 1500-barrel distillation unit, designed by Struthers-Wells-Titusville Corporation. Several obsolete stills will be dismantled, and further improvements are planned.

Gasoline Plant: Skelly Oil Company, near Kingman City, Kansas, building a combination absorption type natural gasoline plant and compression booster station to process gas from the Cunningham field, and deliver gas to lines of the Kansas Gas & Gasoline Company. Gasoline capacity, 5000 gallons daily.

Refinery: Excel Refineries, Inc., Weyburn-Saskatchewan, Canada, is erecting a 500-barrel refinery. Financed by local capital. Designed and built by Don J. Baize.

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FIGURE 1
Right hand view of outside washer

FIGURE 2
Aerial view of inside washer

Automatic Barrel Washer Finds Favor With Eastern Refiners

A NEWLY developed automatic steel barrel reconditioning system, which has been subject to considerable investigation on the part of eastern refiners, and which has been under test for performance data for the past several months, is soon to be announced by The Portland Company, Portland, Maine. The system consists of two separate units, one of which is completely enclosed for the washing of barrels outside, and the other uses a revolving circular table equipped with automatic sprays and for the cleaning of the barrels inside.

The equipment is designed to permit drums entering the "outside-washing" unit, shown in Figure 1, by gravity conveyor, as a "kicker" is provided to automatically kick one drum into the machine at the rate of one per minute. A conveyor is provided in the outside washing unit to move the barrels along and at the same time to cause them to rotate as they are being carried forward. By means of spray pipes provided at frequent intervals inside of the washer, hot caustic solution under pressure is sprayed onto the barrel for the removal of paint and dirt from the outside surfaces. When the barrel is clean the rotating motion is stopped for one minute to allow the drum to drain before coming into contact with the spray of wash water. The drum, being carried forward continuously, again starts to rotate after the draining period and at a point where the hot rinse water is sprayed under pressure to thoroughly wash it. When washed the drum drops from the conveyor onto two stationary rods and is permitted to drain again, until the next drum coming along on the conveyor forces the clean drum from the machine. The drums roll out on a small platform adjacent to the "inside washer."

At this point the operator picks the drum up and places it on the inside washing machine over the spray nozzle and automatic syphon. This unit is a turntable design, as shown in Figure 2, having 12 stations and is entirely automatic with the exception of placing and removing one drum per minute; this being done by hand. The turntable is supported on wheels on a circular track placed on the top outside edge of the tanks containing washing water and cleaning solution. The revolving turntable is supported in the center by a large bearing, and the device is driven by an electric motor.

There are 12 spray pipes equipped with spray nozzles over which the barrels are set. These spray nozzles are controlled by a new design of piston type valves timed to function intermittently at the various stations. These valves permit the washing or cleaning solution, the rinse water, and drying air to enter the drum being cleaned under pressure, and through the single spray nozzle. An automatic syphon is provided to remove the moisture from the recess around the lower head of the drum during the drying period. All solutions are drained from the drum from the same bung hole during the operation and these liquids are returned to their respective tanks by means of specially designed passages. To secure continuous operation a double tank system for both chemical solutions and rinse water is provided for both the outside washer and the inside washer. All of the tanks are equipped with heating coils for heating the washing solutions and rinsing water and also with thermostatic controls to automatically control this temperature. Automatic devices are provided for the removal of scum from the solutions, thus keeping them clean.

Two operators are required for the operation of the system. The power equipment required consists of two one half horsepower electric motors for driving the outside washer and the inside washer equipment, two circulating pumps having one 1½ horsepower motor and one three horsepower motor, for one unit of the system, and two similar pumps with one one horsepower motor and one 1½ horsepower motor for the other unit. Live steam is not used, and the design permits using exhaust steam in the heating coils provided for heating chemicals and rinse water, returning the condensed steam back to the boilers for economy. Heated air is not used and cold air at atmospheric temperature direct from the compressure at 20 pounds pressure is used to dry the drums. Floor space required is 30 feet by five feet five inches for the "outside washing" unit and 13 feet six inches is the diameter of the "inside washing" unit.

New Equipment for the Modern Plant

Pressure Storage Tanks

CHICAGO BRIDGE & IRON WORKS

Two new pressure storage tanks, the first of their type ever constructed, were completed recently at Houston, Texas, to store natural gasoline. The tanks were built for Warren Petroleum Company by Chicago Bridge and Iron Works.

One of the tanks (Figure 1), is of 38,000-barrel and the other of 55,000-barrel capacity. They were fabricated throughout by the shielded arc process of welding.

The most unusual of the features of these tanks is the design which eliminates the loss of liquid by evaporation. The tanks operate under a working pressure of six pounds to the square inch. The tops are convex and the bottoms concave so that they form a pressure dome of the radial cone type. The convex top also provides good water drainage.

In the center of the tank is a small storage tank containing glycerine, used in connection with an automatic pressure regulating device. When pressure is applied to the tank, the glycerine rises to the top of the column and acts as a safety vent to permit the gas to vent to atmosphere when six pound pressure is exceeded. When the pressure is released, the liquid returns to the storage tank.

The smaller storage tank has been in operation for a long enough period to give it a thorough test, and has not lost a fraction of an inch of liquid by evaporation.

Construction of the tanks is unusual. The bottom is reinforced with radial I-beams welded to the bottom plates and tied to the roof beams with vertical tie angles, acting as stay bolts. Each of the cone-shaped sections of the bottom has a concave curve. The top is of similar construction to the bottom.

The appearance of these tanks is unusual, compared to that of the type ordinarily used.

The 38,000-barrel tank is 86 feet in diameter and 38 feet high. The larger tank, shown under construction, is 100 feet in diameter and 42 feet high.

All welding was done by Chicago Bridge & Iron Works, using equipment manufactured by The Lincoln Electric Company, Cleveland, Ohio.

Check Valve

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, has announced a new type electrically operated check valve which was developed to handle compressed air and liquid mediums. The valve is capable of handling both small and large volumes of compressed air, and such mediums as gasoline, water, oil and gas.

The valve may be used as a whistle valve, or it may be inserted in oil or gasoline lines. In the former application, it may be connected in a steam line or air line immediately in front of the whistle. Energizing the coil through a push button will allow the steam or air to pass through the valve to operate the whistle.

Other applications of the valve include its use for controlling the supply of compressed air, controlling the supply of hot or cold water, for controlling other liquid mediums, and controlling the flow of gases of various kinds.

Recording Potentiometer Pyrometer

THE FOXBORO COMPANY

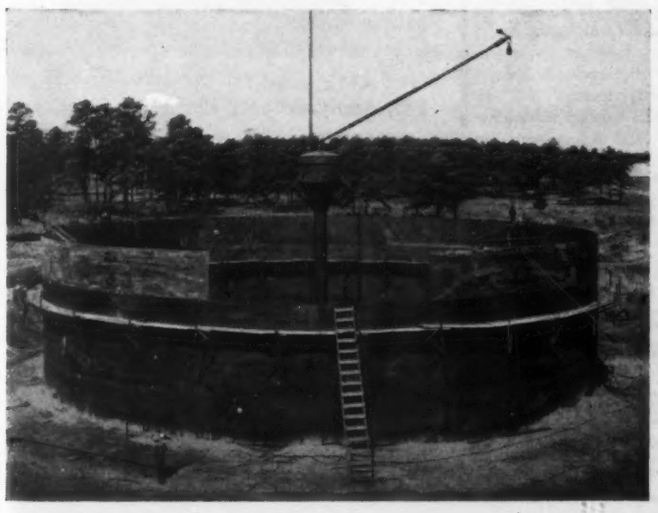
The Foxboro Company, Foxboro, Mass., announces a new recording potentiometer pyrometer which includes a new type of balancing mechanism said to be so designed that it produces a large movement of the pen or print wheel for a small galvanometer deflection and moves the printing mechanism from one end of the scale to the other in a minimum of time, without requiring an extremely fast cycle or rapid motion of the mechanism.

It is claimed that this one feature alone accounts for the instrument's rapid frequency of records, long wearing mechanism, and open, easily-read chart scale. The balancing mechanism consists essentially of a V-shaped drive cam and a friction roller.

The sensing fingers, which detect galvanometer deflection, position the friction roller according to the position of the galvanometer pointer. The V-shaped drive cam then engages and rotates the roller, which in turn transmits its straight-line motion to the slide-wire contact, moving it a corresponding distance. The pen or print wheel, being mounted integrally with the slide-wire contact, moves with it, thus making the record coincide accurately with the measurement.

The recorder is housed in a new fume-tight and dust-proof case that is so designed that it may be either flush or surface mounted. The case aluminum door with large glass window makes the chart and interior of the instrument highly visible.

The mechanism can be swung for-



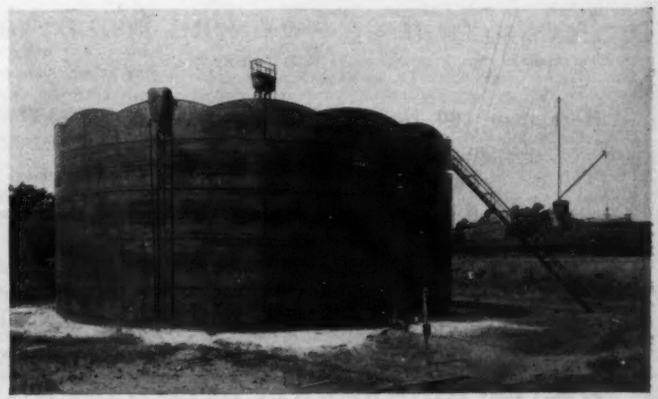
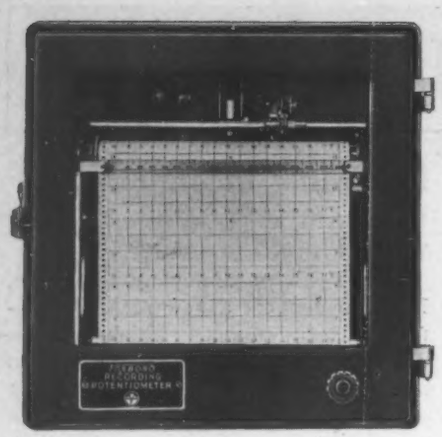


Figure 1. These unique pressure storage tanks were fabricated by the shielded arc process of welding at Houston, Texas.

Figure 2 (left). The tank under construction



Foxboro Recording Potentiometer

ward out of the case, making every part accessible for inspection. The instrument in this position enables close inspection of the drive motor of the instrument that is mounted in rubber bushings which silence the motor and prevent transmission of vibration to the instrument. This synchronous motor is completely enclosed, runs in ball bearings, has a centrifugal starting switch, and has no brushes.

The printing mechanism is mounted on the top front of the Multiple Record Pyrometer. Each record is identified by a color. The printing styles of the rotating print wheel are inked by colored-ink rollers and print the record on the upper surface of the chart paper.

The record dots are square and large enough for the colors to be easily recognized. The ink dries before the record has moved more than a few inches.

Just below the upper chart roller, the chart passes under a scale plate of transparent, unbreakable material with the scale graduations engraved on it. This identifies the temperature values of the chart lines, and since it is transparent, the record can be observed through it.

The connection compartment of the recorder, which is sealed from the interior of the case and is accessible from the outside, allows thermocouple and motor connections to be made or inspected without opening the main compartment containing the mechanism.

High Temperature Thread Lubricant

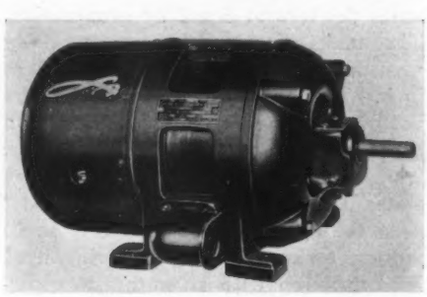
ARMITE LABORATORIES

Armite Laboratories, 1900 East 65th Street, Los Angeles, announces "Bestolite," a new non-gald metallic lead thread lubricant, designed especially for high temperatures. The makers claim it will prevent galding and seizing in superheated steam lines, header studs, engine and pump studs, and those "hard to get at" bolts that always give trouble. The joints, it is said, will thereafter break easily, regardless of temperature or time. The reason "Bestolite" will stand these high temperatures and still be effective, is that the lead contained therein is confined in the thread during the heating and cannot escape. When cooled, the lead condenses remaining in a finely divided state, without oxidizing, hardening, or going to a powder, retaining its original lubricating and sealing effect. Due to the high lead contents, being in a finely divided state, almost colloidal, the compound retains its body, will not blow out, and will effectively seal against high pressure, even with crossed or imperfect threads. The makers claim the use of this thread lubricant will cut repair costs, speed up work, and increase plant efficiency.

Electric Motor

THE LOUIS ALLIS COMPANY

The Louis Allis Company, Milwaukee, Wisconsin, has announced a new self-contained capacitor motor, of the single phase type. The outstanding features of this new type of motor are listed as being built-in capacitor, and automatic cut-out switch.



Louis Allis Motor

The cut-out switch has been carefully tested to cut out the capacitor at the correct speed, and is not affected by voltage or starting load variations.

The motor is available in sizes ranging from a third to three horsepower, and in either horizontal or vertical type.

Combustion Test Set

THE HAYS CORPORATION

The Hays Corporation, Michigan City, Indiana, announces a new inexpensive, light weight portable combustion test set housed in a sturdy stamped steel case. The set combines the Hays CO_2 analyzer and the Hays dry type pointer gage. A small fountain pen type flue gas thermometer can also be supplied. The set weighs only nine pounds. There are convenient reels and clamps for the rubber tubing and accessories and the varrying handle swings out of the way when unsnapped. A test can be started as soon as the case is opened and no time is lost in leveling the instrument, which can be hung on a nail or placed on a table or any flat surface. The size 7⅞ by 5 by 15 inches.

SOUTHWESTERN

Absorption Plants and Stabilizers

for the

Production of Gasoline from Natural Gas

♦

More than 100 Units now operating in MID-CONTINENT Gas Fields.

Are you wasting your Gas?

Write, Wire or Phone SOUTHWESTERN

Known all over the world for the Efficiency of their Equipment.

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Exclusive Manufacturing Agents in U. S. A. for

DONNELLY COIL AND QUENCH TYPE CRACKING UNITS.

We are prepared to quote you on Turn-key Installations.

SOUTHWESTERN ENGINEERING CORP.

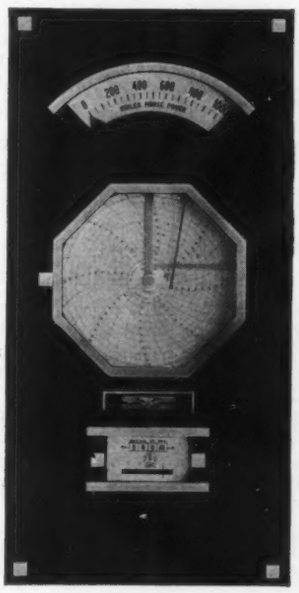
4800 SANTA FE AVENUE LOS ANGELES, CALIFORNIA

***District Office* — 606 MAYO BLDG., TULSA, OKLA.**

Flow Meters

REPUBLIC FLOW METERS CO.

Republic Flow Meters Company, Chicago, Illinois, announces complete re-vamping in design of its line of flow meters, in which the basic principle of operation is practically identical with the Republic meters serving the industry in the past. The new design is built around the cartridge sealed element, which consists of the actuating unit being designed and built to fit into a metal cartridge forming a compact, sturdy element ready for mounting on the instrument board. There are three types of reading instruments, the indicator, the recorder and the integrator, each with its actuating mechanism mounted in a separate cartridge sealed element, which is interchangeable and may be easily removed from the back of the panel. The metal cartridges protect the elements from dirt, moisture and abuse. This feature of mounting each actuating unit as a separate element simplifies the meter assembly, and permits the plant engineer to easily and quickly remove any specific element without disturbing any of the other units.



Republic Flow Meter

The meters are mounted nearly flush with the front of the panel board. The bezel of the instrument extends about one inch from the panel. The entire panel is the work of a prominent designer who has specialized in the modern design of industrial equipment. The meter is distinctive in appearance. The bezels are of cast aluminum with black marine finish, and polished aluminum trim.

This simplification in instrument design and assembly has been carried through the entire line of Republic reading instruments, including the two- and three-pen multiple recorders which combine records of flow, pressures, temperatures, etc., on one chart.

In the new design the pen adjustment is accessible from the front of the instrument, the pen is automatically lifted from the chart when the chart knob is unscrewed and the chart knob is part of the pen release assembly and is always held in position. The accuracy of the integrator is not dependent on, nor affected by, the clock mechanism and operates independently of other reading instruments.

A new boiler horsepower indicator has been introduced, known as the "CS-24" indicator, which has a 24-inch porcelain enamel dial with large white figures on a black enameled field, so that it may be easily read from a distance.

High Pressure Needle Valve

CRANE COMPANY

Crane Company, 836 S. Michigan Ave., Chicago, has placed on the market a newly designed line of high pressure needle valves, made as small and compact as possible without sacrificing efficiency or quality. Made from car-

3 WEEKS for the JUDGE
3 MINUTES for YOU

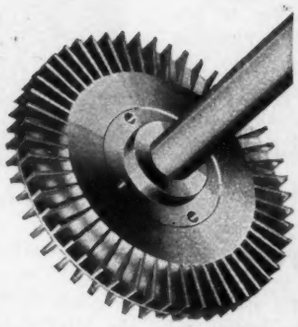
NOT so long ago, it took 3 week's time and almost 1,000 printed pages of technical testimony to convince a Court of Equity why Westco Turbine Pumps are DIFFERENT from all other pumps using centrifugal force.

With all due respect to His Honor, that much time and type are not needed to explain Westco's difference. We're sure you'll get the point from these two brief paragraphs:

In all other centrifugal pumps, a given particle of liquid leaving the Impeller Blade DOES NOT come back into contact with the Blade. The Impeller acts on it only ONCE.

In a WESTCO, the same particle of liquid is repeatedly engaged by the Impeller Blades. This re-energizing action produces pressures which in many cases are as much as 20 times greater than those which can be produced by centrifugals of the former type.

Westco users get the benefits of Multi-Stage performance while only paying for Single-Stage construction.



Westco's Multi-Vaned Impeller. It does the "business".

Will Not Vapor Bind!

These modern, Refinery Pumps handle light, volatile gasoline, propane, etc. of 100° to 140° A.P.I. against pressures up to 300 lbs.—and they do it WITHOUT vapor binding.

Automatically Adjust

Even if the operating pressure might fluctuate considerably, Westco automatically adjusts itself to such changes. A steady, non-pulsating flow is assured at all times. By increasing the efficiency of the towers, this characteristic makes Westco the ideal pump for feed and reflux duty on high pressure stabilizers. Our Refiner friends also like Westcos for Still Charging and for handling Hot Oil, Fuller's Earth, Chlorine Treating Solutions, Mineral Seal Oils, Naphtha, Brine, Water, etc.

Get the Details

Just fill in the coupon below and mail it today for FREE Catalog together with Performance and Selection Tables. WESTCO PUMP CORPORATION, Davenport, Iowa. *Branches:* New York, Philadelphia, Chicago, Los Angeles and San Francisco. *Representatives in 50 Principal Cities.*

COUPON BRINGS DETAILS

WESTCO PUMP CORPORATION,
Davenport, Iowa. Dept. N-12

Gentlemen: Without obligation, please send me your Catalog and Performance and Selection Tables for Westco Turbine Pumps.

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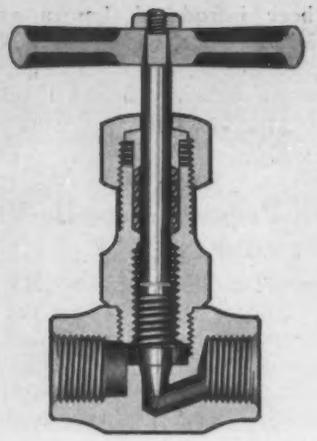
WESTCO *TURBINE* PUMPS

HIGH PRESSURE - - - SINGLE STAGE



bon steel or Excelloy (a high chrome, stainless iron) their sturdy, rugged construction is said to make them suitable to service where measuring pressures or volume of flow of liquids or gases is necessary, and where a gradual release of pressure is necessary to prevent damage to such delicate instruments as pressure gauges and meters. Particularly adaptable to high pressure gauge lines on oil service, these valves can also be used on water or gas lines orifice meters, regulator leads, and bypass connections in refineries, or on gas and gasoline distributing systems where high pressures at relatively low temperatures are encountered. The valves have such improvements as long stem threads with liberal engagement in all positions, deep stuffing box with gland, tight metal to metal bonnet joint, long tapered plug disc, and extra long bonnet thread.

Attach this to your letterhead

We make regulating valves for every refinery service. Check the items below on which you want complete information, including prices. Attach to your letterhead, and mail to

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
275 South Street,
NEWARK, N. J.

- ☐ Campbell Boiler Feed Water Regulator
- ☐ Reducing Valves
- ☐ Damper Regulators
- ☐ Temperature Regulators
- ☐ Pump Governors
- ☐ Float Valves
- ☐ Swing Joint Fittings
- ☐ Thermostats
- ☐ Balanced Valves
- ☐ Control Valves

FOUR YEARS WITHOUT COST

Here is a typical example of service given by Atlas Products. The chief engineer of a large institution (name on request) recently wrote regarding a valve like the one shown here:

"I am sending an Atlas Reducing Valve to be repaired and regulated. I wish to reduce from 125 lbs. to 75 lbs. This valve has operated four years without cost."

Type "A" Reducing Valve, Auxiliary Operated

Form the habit of putting all of your regulating problems up to Atlas Engineers. No obligation.

Timing Contactor

AUTOMATIC TEMPERATURE CONTROL COMPANY

Automatic Temperature Control Company, Philadelphia, has added a new adjustable timing contactor to its line of control equipment. The unit, termed type 1290, is sturdy in construction, has a minimum number of parts, will operate in any position without levelling,

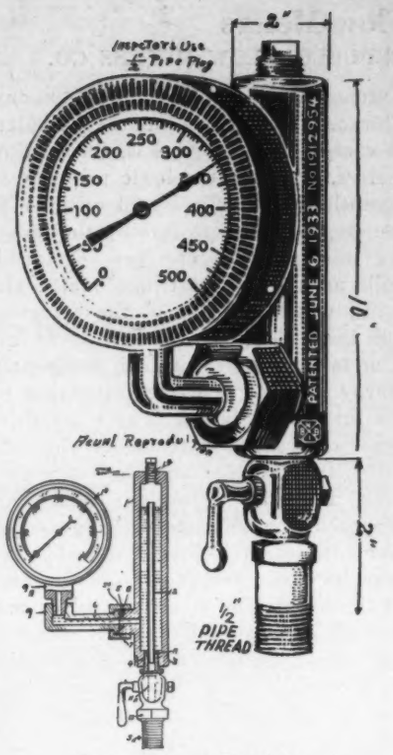
Timing Contactor

and is unaffected by vibration, yet the elapsed time can be set to a split scale division for any range desired within the dial selected. Power is obtained from a reversing synchronous motor and the contact arm moves alternately clockwise and counter-clockwise with the time limit set, making a 10 ampere 110 V.A.C. load circuit for an adjustable time at either extreme of its travel. Timing contactors of this design are also available to be actuated from a momentary contact switch, run for the time cycle for which they have been adjusted and stop until the starting switch is again energized. These cycle stop type contactors make and hold their load circuit at the expiration of the time set, or they may be supplied to make the load circuit at start of the time cycle and break it when the time set has elapsed.

Steam Gauge Protector

BOILER EQUIPMENT SUPPLY CO.

Boiler Equipment Supply Company, Oklahoma City, Oklahoma, is offering the Thompson Steam Gauge Protector, a device which provides an attachment for protecting boiler pressure gauges. It functions by preventing the live steam from coming in contact with gauge springs.



Steam Gauge Protector

The protector was also designed to protect gauges during freezing temperatures, to eliminate shut-down time when gauges are being inspected, and to protect human life. It is filled with spirits of glycerine in cold weather, and in warm weather water is used.

Items About Manufacturers

Eagle-Picher Lead Company, Cincinnati, Ohio, announces the following appointments in the personnel of the Insulation Division:

H. R. Shidel has been transferred from Joplin, Missouri, to Kansas City, where he is district sales manager with offices at 2801 Terrace. Marvin Smith now is district sales manager at Tulsa with offices at 514 West 7th Street, and C. B. Lynde is district sales manager at Dallas with offices at 2225 Laws Street.

D. W. Haering & Company, Inc., Chicago, manufacturers of H-O-H water treating materials, announced opening a New York office at 1451 Broadway, and appointment of William Wright as district manager.

Louis Allis Company announces appointment of E. F. LeNoir as representative with headquarters in Allentown, Pennsylvania. Mr. Le Noir was formerly president of Union Electric Manufacturing Company.

The Struthers-Wells division of the Struthers-Wells-Titusville Corporation, Warren, Pennsylvania, announces appointment of Yuba Manufacturing Company, 351 California Street, San Francisco, as sales representative for the West Coast; Mine & Smelter Supply Company, 1422 17th Street, Denver, Colorado, as representative for the Rocky Mountain district; and O. E. Berg, 2325 Gulf Building, Houston, as representative for Oklahoma, Louisiana, and East Texas.

The WEBSTER

PERFORMANCE

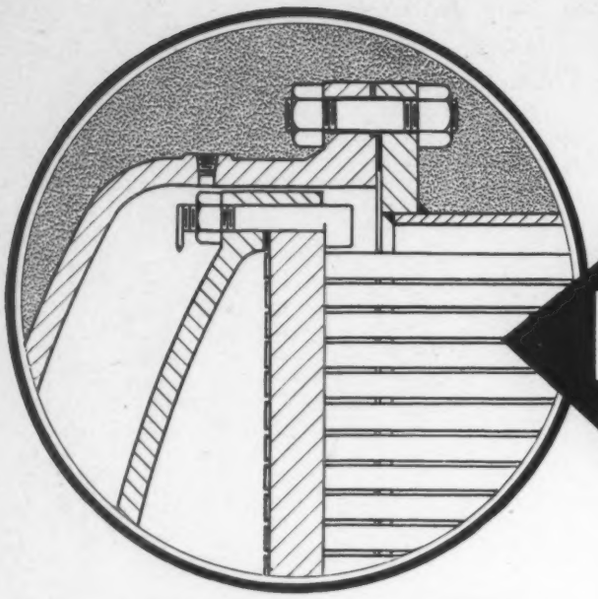
Never Before Equaled

THE WECO SERIES 1300 STEAM OR AIR ATOMIZING OIL BURNER has proven its merits beyond doubt by actual performance over a period of one year of operation on various types of stills and boilers, burning various grades of oils, including acid sludge of many grades. The outstanding features developed are HIGH CAPACITIES, HIGH TURN DOWN RATIO, LOW STEAM CONSUMPTION, LOW OIL PRESSURE (40 lbs. or less), FOR MAXIMUM RATING, NON-CLOGGING (3 months run without removal from furnace), RESISTANCE TO ACID SLUDGE CONDITIONS (8 months on the worst acid condition with no deterioration), COMPLETE ATOMIZATION, making possible the discontinuance of gas for pilots to keep burner lighted in low temperature units. We are now in a position to furnish this equipment on a positive guarantee basis of performance.

ENGINEERING COMPANY

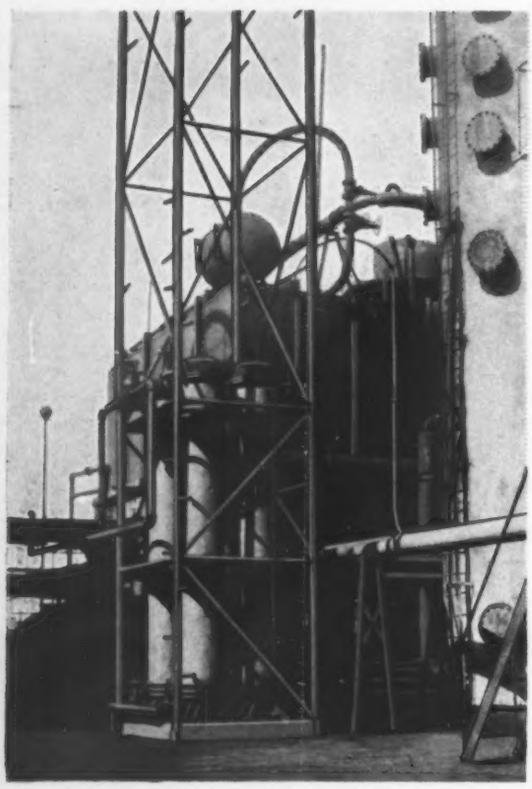
Tulsa, Oklahoma

a NEW and Superior



FLOATING HEAD JOINT

(Patent No. 1,895,735)



GONE are floating head leaks due to warping of split ring construction through uneven bolting strains!

Vogt alloy steel "L head" bolts, with supported shanks and index heads, make full bearing under the tube sheet certain and hold the gasket tight. They can't be mislaid or replaced with inferior bolts because they need not be removed from the head cover.

Higher operating efficiencies result from a closer fit between the tube bundle and shell and a reduction of ineffective surface by bringing the floating head nearer the shell flange.

Let us tell you more about the advantages of Vogt heat exchanger design and construction.

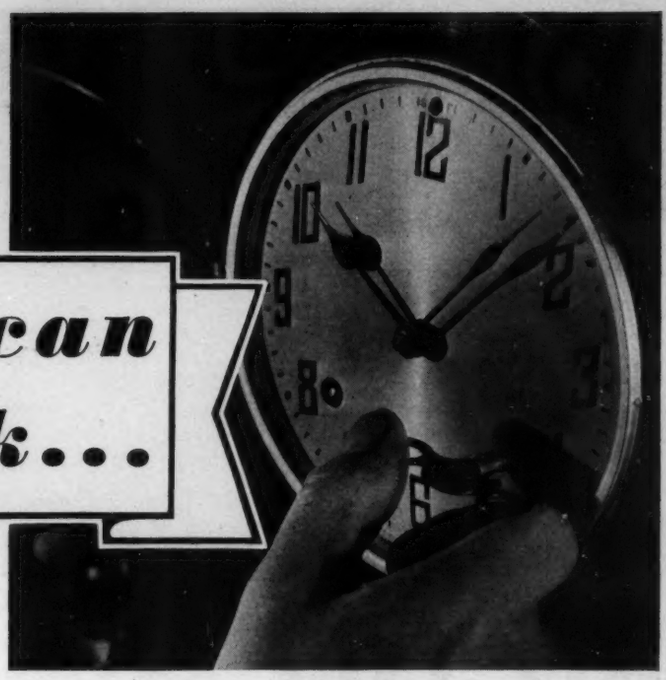
HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KY.

New York Chicago Cleveland
Philadelphia Dallas

Manufacturers of: Heat Exchangers, Water Tube Boilers, Drop Forged Steel Valves and Fittings, Oil Refinery Equipment, Ice Making and Refrigerating Machinery

Vogt HEAT Exchangers

NRA MEMBER U.S.
WE DO OUR PART



If a man can run a clock...

..he can run a Mason-Neilan Instrument

It's not hard to wind a clock and set it.

It's no harder to set a Mason-Neilan Compensated Control Instrument.

Like almost all *perfected* devices, Mason-Neilan Instruments are *simple.* The average refinery or gasoline plant operator can install, adjust and repair them with no trouble at all. He can adjust the sensitivity and the degree of compensation to synchronize them exactly with the speed of the process. He can adjust the Control Valve Compensator, the exclusive device that definitely eliminates hunting, cycling and over-control on all Mason-Neilan Instruments. And the whole job is as easy as starting a clock!

What's more, *all* Mason-Neilan Instruments — whether for pressure, temperature or flow — are adjusted exactly the same way. When you understand one you understand them all. Even the parts are readily interchangeable — a fact that gets a big hand from maintenance men.

It's often said, and it's true: Mason-Neilan Instruments have reduced Control to a Common Denominator. Specify them and you profit from the latest developments in simplified, automatic control — of temperature — of pressure — of flow.

MASONEILAN

MASON-NEILAN REGULATOR COMPANY

Consolidation of Mason Regulator Co., Boston and Neilan Co., Ltd., Los Angeles

1190 Adams Street . . . . . Boston, Massachusetts

BALTIMORE, Whitaker Bldg. . . . . Morton McI, Dukehart & Co.
CHICAGO, 1525 E. 53rd St. . . . . Gordon Thomason, Mgr.
HOUSTON, 1400 Conti St. . . . . Maintenance Engineering Corp.
LOS ANGELES, 2446 Enterprise St. . . . . Tunnell & Co.
MONTREAL, CANADA, 620 Cathcart St., W. . Maurice Peiler, Mgr.
NEW YORK, 19 Rector St. . . . . Rudolph B. Werey, Mgr.
PHILADELPHIA, 930 North Front St. . . . Baeuerle & Morris, Inc.
PITTSBURGH, Clark Bldg. . . . . Bruce Irwin, Mgr.
ST. LOUIS, 2726 Locust Blvd. . . . . O'Brien Equipment Co.
SYRACUSE, N. Y., 640 Gurney Bldg. . . O'Brien Steam Specialty Co.
TULSA, 409 East Archer St. . . . . Moorlane Co.

"YOU CAN BE SURE OF MASON-NEILAN PRODUCTS"

5808

POTENTIOMETER
STABILOG

A New

NOW Stabilog Control

REG. U.S. PAT. OFF.

For Temperatures Up To 2800° F.

Here is an entirely new conception of control!

Extremely accurate measurement, not handicapped by distance or range, is given by the Potentiometer Pyrometer System. The control is Stabilog Control—air operated! There is nothing like it. It gives completely automatic control in any situation.

The Stabilog System of control entirely eliminates manipulation of control equipment. It automatically corrects the process at a rate equal to the change in demand, and therefore, eliminates hunting or over-controlling.

Designed and built for refineries, this instrument is housed in a fume-tight case with internally sealed connection box. The universal case may be mounted either flush or surface.

THIS COMBINATION:—The Stabilog System of Control the Potentiometer measuring system produces results not yet obtainable with any other device.

THE POTENTIOMETER STABILOG:—

the recording Potentiometer Pyrometer results in a new standard of process control. The same thermocouples are used for both recording and controlling—but different mechanisms, unobstructed in their action, record and control the temperature accurately. As many as six controller records can be made on one Recorder—with *one recorder mechanism* and *one chart.*

Separate thermocouples may be used for recording and controlling and are often very desirable.

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

Standard in Refinery Control!

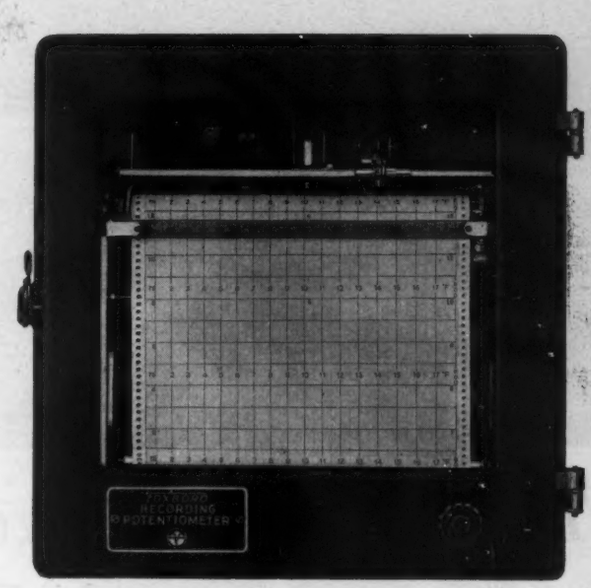
The running mate of the Potentiometer Stabilog is this new Multiple Recording Potentiometer Pyrometer. It also is housed in a fume-tight universal case. Accuracy and durability are its outstanding characteristics.

ACCURACY

The slide-wire contact of the potentiometer system is mounted integrally with the recording mechanism. **This is not only the simplest mechanical design, but also the most accurate. There is absolutely no lost motion between the measuring device and the record.**

DURABILITY

The balancing mechanism is entirely new and unique in design. It moves the print wheel rapidly from one end of the scale to the other without requiring fast movement of the mechanism. This means minimum wear and maximum trouble-free life. It also makes possible a very open chart scale and rapid frequency of records.



POTENTIOMETER RECORDING PYROMETER

Maximum legibility, so necessary to any industrial instrument, is assured by the open scale of the twelve inch chart. The different records, identified by distinct colors, are in plain sight as soon as they are made.

THE FOXBORO COMPANY

FOXBORO, MASS., U. S. A.

BRANCH OFFICES IN PRINCIPAL CITIES

Complete Refinery Control

The symbol at the right is emblematic of the unique Foxboro Potentiometer balancing mechanism. It is the seal of rapid, accurate temperature recording.

SEND FOR BULLETIN 190

It gives detailed information about the Foxboro Potentiometer Recording Pyrometer. Use this coupon for convenience.

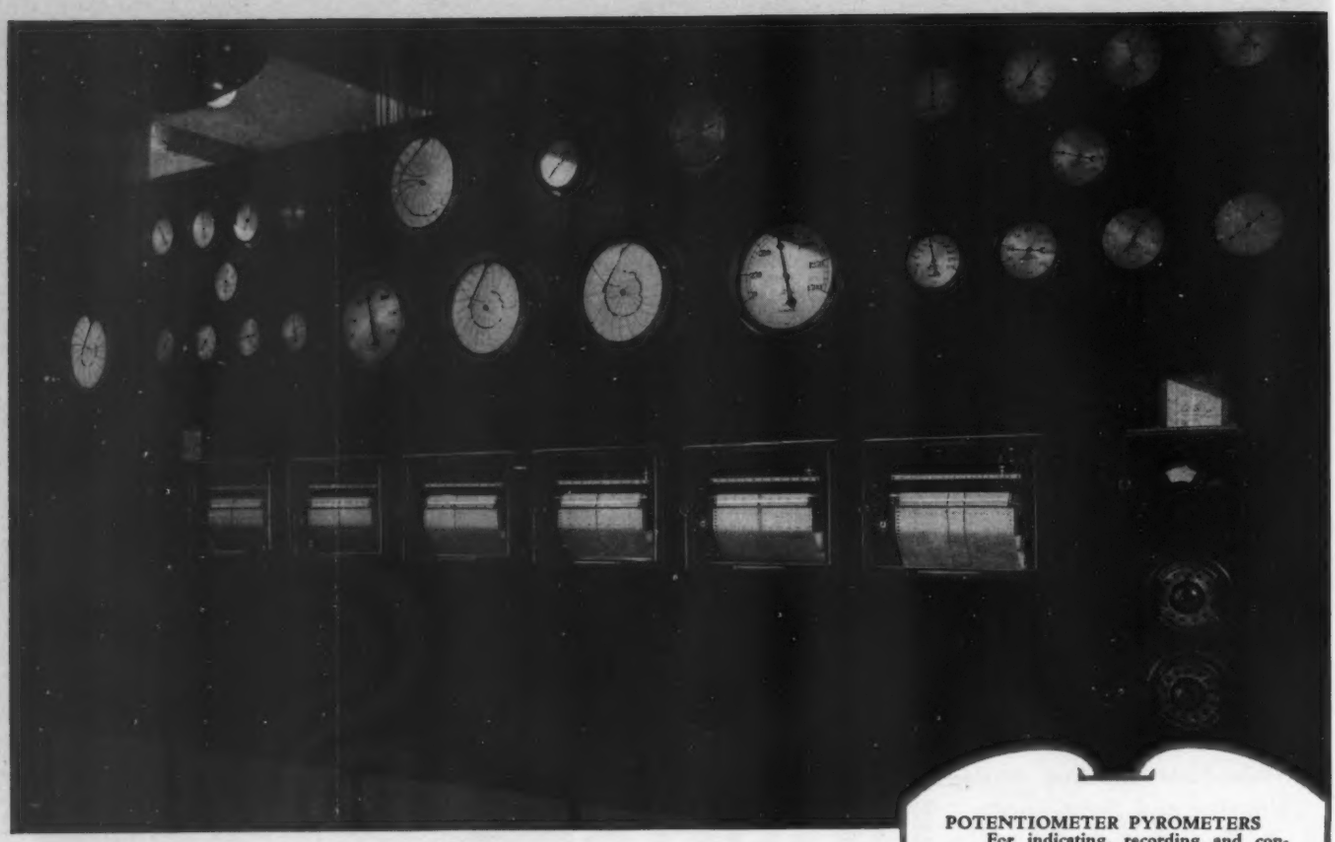
THE FOXBORO COMPANY,
Foxboro, Mass.
Gentlemen:

Please send me Bulletin 190, "The Foxboro Potentiometer Recording Pyrometer."

Name .....

Address .....

State .....



Throughput Safeguarded!
...*at* "MAGNOLIA"

High throughput, maximum yield and close cuts are obtained continuously at "Magnolia's" big Beaumont Refinery — because their operators can hold all process temperatures, pressures and flows within *closer* limits.

The accuracy of Brown Indicating and Recording Potentiometers, Controlling Potentiometers, Recording-Integrating Flow Meters, Flow Controllers, and Indicating and Recording Pressure Gauges, assures finer cuts and the maximum profitable yield. Above illustration of the centralized control board shows a few of the 54 Brown Indicators, Recorders and Controllers in use at this Magnolia plant.

Today, more than ever before, profitable operation demands dependable, uninterrupted control of processes. Check your instrument requirements with the list at the right — and send for full information on any or all of these Brown refinery instruments.

POTENTIOMETER PYROMETERS
For indicating, recording and controlling temperatures in stills, towers, furnaces, flues, lines, etc., in and around the oil refinery. Catalog 1101.

FLOW METERS
For indicating, recording and controlling the flow of oil, gasoline, gas, steam, water, air and other liquids, gases or vapors. Catalog No. 2002 or 2201.

CO_2 METERS
For indicating, recording and controlling % CO_2 in still and boiler furnace to check and insure proper firing efficiency. Catalog No. 3004.

AUTOMATIC CONTROLS
For automatically controlling, within desired limits, temperatures, pressures, flows, tower levels, speeds and % CO_2. Catalog No. 8008.

THERMOMETERS
For indicating, recording and controlling temperatures ranging up to 1200° F. Catalog No. 6702.

PRESSURE AND VACUUM GAUGES
For indicating, recording and controlling pressures and vacuums in stills, towers, steam and power plants, etc. Catalog No. 6702.

LIQUID LEVEL GAUGES
For indicating, recording and controlling the level of petroleum and petroleum liquid products in tanks, towers, etc., at a distance. Catalog No. 6702.

RESISTANCE THERMOMETERS
For indicating, recording and controlling low temperatures such as are encountered in de-waxing plants. Catalog No. 93.

TACHOMETERS
For indicating, recording and controlling speeds of machines in the refinery. Catalog No. 46.

NRA

THE BROWN INSTRUMENT COMPANY

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Branches in 22 Principal Cities.

Brown Instruments

"to measure is to economize"

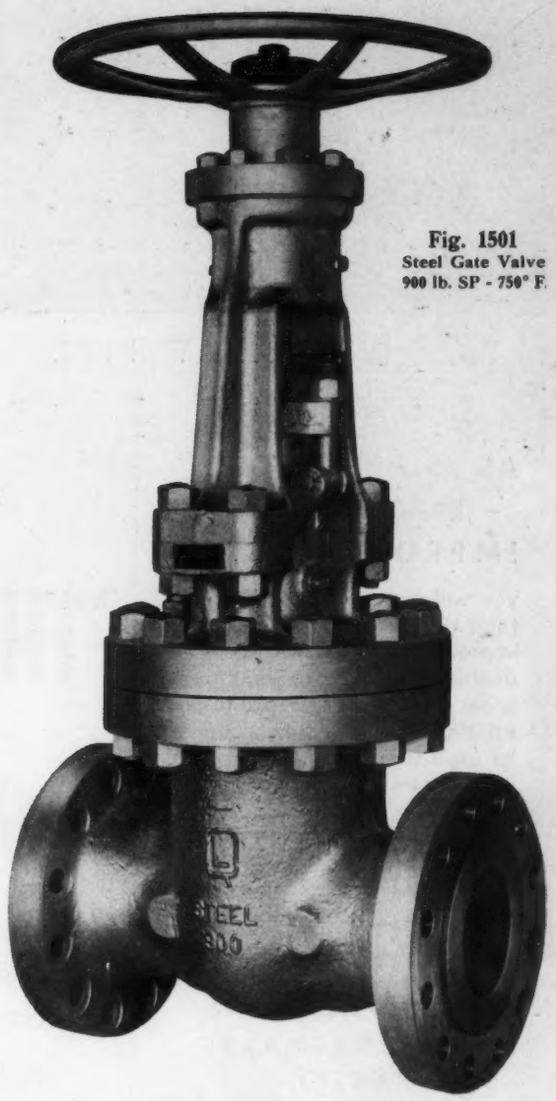

Fig. 1501
Steel Gate Valve
900 lb. SP - 750° F.

Designed for the Modern Refinery~~~

LUNKENHEIMER
Steel Valves

The modern refinery - carefully planned for increased efficiency, larger capacity, and higher operating pressure and temperature - demands equipment designed specifically for its needs.

Lunkenheimer Steel Valves are available in a variety of types and sizes to satisfy all present-day service requirements, at pressures from 150 up to 1500 lb. and temperatures as high as 1000° F. The line includes gate, globe and angle, swing check and piston check valves in all commercial sizes.

As no one combination of materials should be recommended for all conditions, a choice of materials as well as types is offered. Bodies and bonnets may be made of carbon or alloy steels, and trimmings of various alloys selected to suit the installation. Valves may be constructed for flanged or welded piping and equipped with motor control or gearing.

The Lunkenheimer Company is prepared to assist you in refinery valve problems. Write for information.

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON
PHILADELPHIA SAN FRANCISCO
EXPORT DEPT 318-322 HUDSON ST., NEW YORK

LUNKENHEIMER VALVES

15-64-89

IN THE FIELD....AT PIPE LINE STATIONS....OR REFINERY....

AS YOU PLAN YOUR ELECTRICAL IMPROVEMENTS

you will want to take advantage of the latest technical improvements in electrical conductors. You will also want to know about other special insulating materials which can be used to prolong the service lifetime of your wiring. We will be glad to help you in specifying wiring materials which are electrically, mechanically and chemically correct for the purposes intended.

◆

IN YOUR WIRE AND CABLE PURCHASES SPECIFY GENERAL CABLE

Cables for Underground Power Distribution within the refinery.

Bare and Insulated Wires for Pole Line Installation.

Power Cables and Wiring for Pumps, Compressors, Welding Rigs, etc.

"Thiokol" Sheathed Wires and Cables for Oil, Acid, Alkali and other hazardous conditions.

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Insure Your Electrical Circuits

...by Specifying

"THIOKOL" SHEATHED

Rubber Insulated

WIRES and CABLES

Insulation highly resistant to deterioration is a vital necessity for protection not only against service interruptions but also against short circuits and their attendant *fire hazard.*

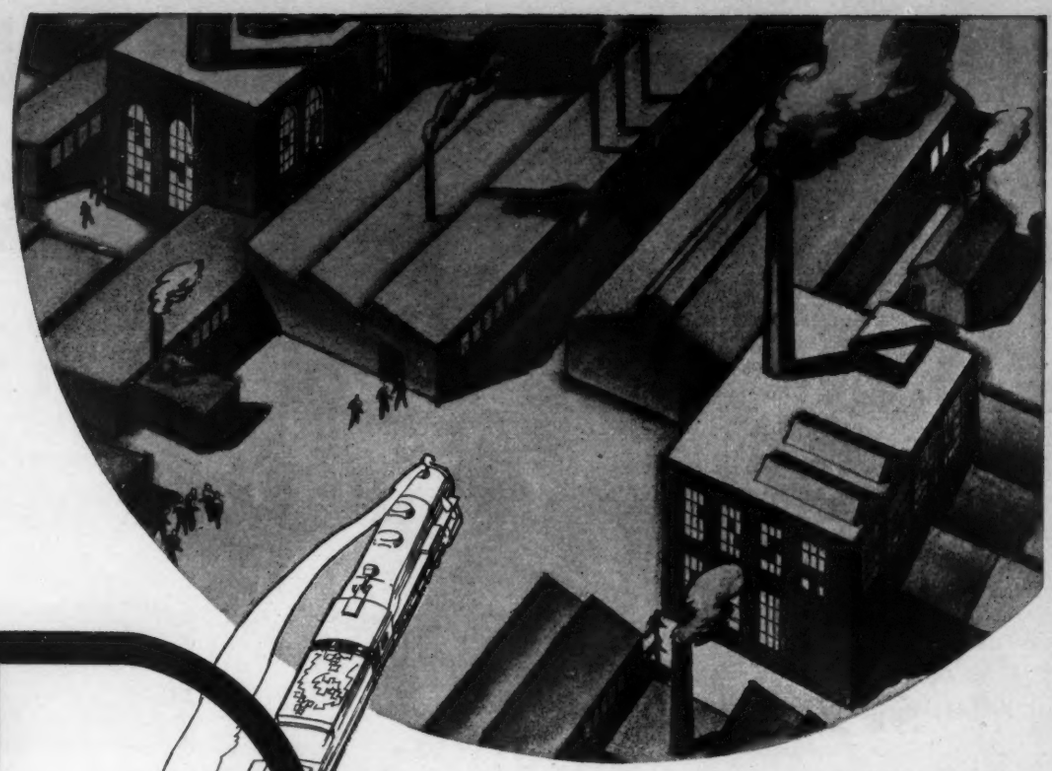
The advantages of "Thiokol" Sheathed Wires and Cables are manifest:

1. *Highly resistant to oils or moisture, acids or alkalis.*
2. *Resists to a very high degree the deteriorating effect of sunlight or weather.*
3. *Longer life—whether installed underground or aerial.*

Our engineers will be glad to consult with yours, or to forward you data, on request.

GENERAL CABLE CORPORATION

420 LEXINGTON AVENUE, NEW YORK CITY • OFFICES IN PRINCIPAL CITIES



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76% Caustic Soda

—always a uniform high quality product,—is being used by the leading refiners for the purification of rancid crude oil and in the treatment of gasoline for the removal of sulphur compounds. DIAMOND Brand is readily available in any quantity your requirements demand.

DIAMOND ALKALI COMPANY
PITTSBURGH, PA.
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Any Special Equipment For Your Refinery

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SPECIAL
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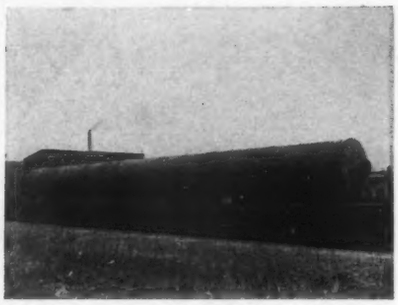
Any Equipment for Your Individual Need



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Have Equipment
Well Made.
We Build Only
The Best.

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Rail or Water Shipments.

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Estimates on Request.

Sun Shipbuilding & Dry Dock Co.

Chester, Pa.

"PLASTIC INSULATION can be applied for much less labor cost than Block Insulation . . . . *using your own workmen"*

We have no desire to start a controversy over the relative merits of Block versus Plastic Insulation. We sell both kinds — and we believe there are times and places where it is necessary to use the Block variety.

Also, there are Plastic cements on the market which we would decidedly *not* recommend. We *do* know our own Eagle "66" Insulating Cement, however. We know its theoretical and its actual advantages, on all kinds of jobs. And we believe in it so thoroughly that we want to bring its qualities forcibly to the attention of heating engineers.

The advantages of Eagle "66" Cement over Block Insulation we have listed briefly below. It forms a continuous, one-piece insulation that sticks firmly to a hot surface. There are no joints or seams to open up. Repairs are quickly, economically made. Application of "66" is easy, economical. It can be done with your own workmen. Only *one* material, instead of two or three, is needed for the job. The material is exceedingly strong — and 100% reclaimable.

It would seem to us that anyone using Eagle "66" once would adopt it straight off. That is why we urge you to send for a free sample and our booklet telling the detailed story of the "springy ball" construction of Eagle "66." Use the coupon below.

We make a complete line of heat insulation, including pipe covering, blanket insulation, blocks, waterproofing cement, boiler setting cement, etc. Catalog upon request.

EAGLE "66"

Insulating Cement—embodying the new principle of "springy ball" construction

Advantages of PLASTIC Insulation (WITH EAGLE "66" INSULATING CEMENT) over BLOCK Insulation

1. Plastic Insulation sticks to a hot surface, becoming an efficient one-piece insulation — with no seams or joints to open up to escaping heat. Blocks often pull away — shrink and open up.

2. Eagle "66" Cement offers greater ease and economy of application. Often can be applied for one-half labor cost of Block, using your own workmen. This gives greater control over work, as well as economy. Cement goes on easier around corners and over irregular surfaces.

3. With Cement only one material is needed, and *no* special tools. With Blocks you need several accessories — including a finishing cement.

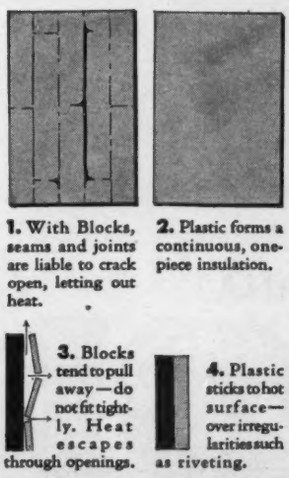
4. After it is applied Eagle "66" insulation is several times stronger than a section of Block.

5. Repairs, changes and alterations are much easier and less expensive.

6. No loss from breakage with "Eagle "66".

7. It is 100% reclaimable.

8. With all these advantages, Plastic (with Eagle "66") is no more expensive than Block.



1. With Blocks, seams and joints are liable to crack open, letting out heat.

2. Plastic forms a continuous, one-piece insulation.

3. Blocks tend to pull away — do not fit tightly. Heat escapes through openings.

4. Plastic sticks to hot surface — over irregularities such as riveting.

● **THE EAGLE-PICHER LEAD COMPANY**
DEPT. RN12, CINCINNATI, OHIO

● Please send me your free sample and booklet about Eagle "66" Insulating Cement.

*Name*_____

*Firm*_____

*Street*_____

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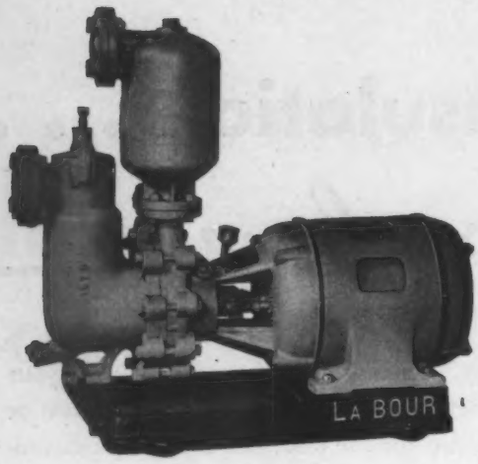
Officially Approved for Skimming Service



A large eastern refinery installed a LaBour pump in a skimming system for the prevention of pollution from waste water. So successful has this installation proved itself that the civil authorities controlling the water into which the waste is discharged have given it 100% official approval.

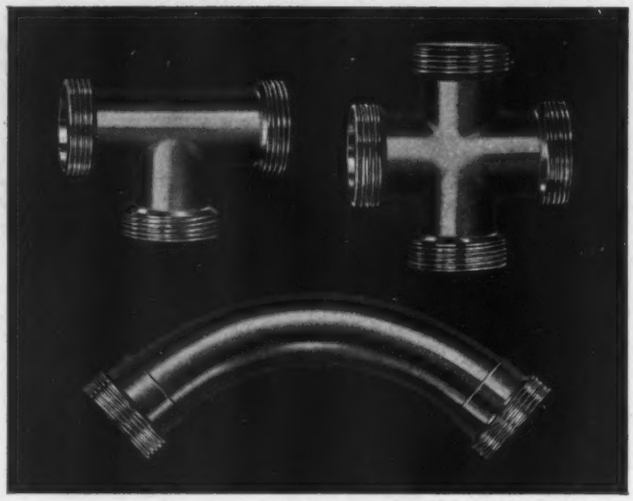
Effective skimming is dependent upon the pump and none equals the LaBour Self-Priming Centrifugal pump for this service. They operate smoothly whether the suction be open to the air or not.

Let us consult with you regarding this and other refinery applications for LaBour pumps.

THE LABOUR CO., INC.

1207 Sterling Ave.
ELKHART, INDIANA

PITTSBURGH PIPING FABRICATORS OF STAINLESS STEEL



Welded Fittings of 18-8 Stainless Steel

STAINLESS STEEL CASTINGS

STAINLESS STEEL PIPE BENDS

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STAINLESS STEEL VAN STONE LAPS

STAINLESS STEEL HEAT EXCHANGERS

Also any special refinery equipment of stainless steel fabricated to your specifications.

Let us quote on your stainless requirements.

PITTSBURGH PIPING & EQUIPMENT COMPANY

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Blaw-Knox *Welded* PRESSURE VESSELS *for Oil Refineries*

A super-inspection of Blaw-Knox Ductilwelded Pressure Vessels by the most modern "X" Ray equipment is a part of Blaw-Knox service to its customers. This is just one of the many safeguards surrounding the fabrication of Blaw-Knox equipment to insure its performance under service conditions.

Your inquiries are solicited for all types of welded pressure equipment including the following:—

ABSORBERS
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ACCUMULATORS
ATMOSPHERIC AND VACUUM STILLS
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BUTANE GAS RECEIVERS
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DEPHLEGMATORS
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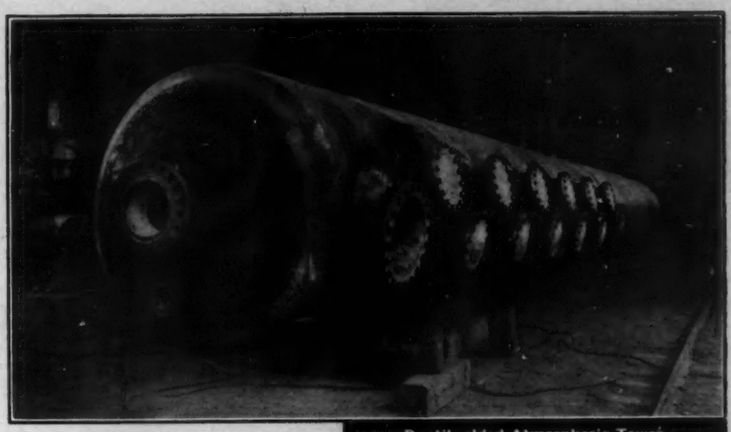
HEAT EXCHANGER SHELLS
GREASE KETTLES
PRESSURE STILLS
REACTION CHAMBERS
RECEIVERS
RECTIFYING COLUMNS
REFLEX TOWERS
SATURATORS
SCRUBBERS
SOAKING DRUMS
STRIPPING DRUMS, ETC.

NRA NATIONAL RECOVERY ACT WE DO OUR PART



Ductilwelded Atmospheric Tower, 7'0" I.D. x 58'0" Long.

Ductilwelded Pressure Chamber, 72" I.D. x 34'0" Long. 2" Shell Plate. 2½" Heads

Welded Chrome Nickel Vessel. 8'0" I.D. x 25'6" Long. Annealed above 1800° F.

BLAW-KNOX COMPANY

Farmer's Bank Building Pittsburgh, Pa.
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Export Division:—Blaw-Knox International Corporation, P. O. Box 915, Pittsburgh, Pa.

BLAW-KNOX

TRADE MARK REG. U.S. PAT. OFFICE BLAW-KNOX

Have *Your* Steam Traps Stood the Test?

WHEN the going has been tough, have your steam traps met every requirement? Have they piled up annoyance, expense and waste or have they built a record of dependable service with little cost and trouble on your part?

Armstrong Steam Traps have come through severe tests for more than 20 years. They have saved money and have speeded up heating and processing for thousands of leading users.

You can enjoy "complete satisfaction" in steam trap service — the Armstrong guarantee — by selecting an Armstrong trap for every need, by utilizing the Armstrong service organization to the fullest extent, and by judging traps on the basis of performance and not on such false standards as pipe sizes or cost per pound.

Your nearest Armstrong representative will welcome an opportunity to help correct any troubles you have had with traps and to put one or more Armstrongs at your service for 90 days free trial.

Armstrong Machine Works
852 Maple Street
Three Rivers, Michigan

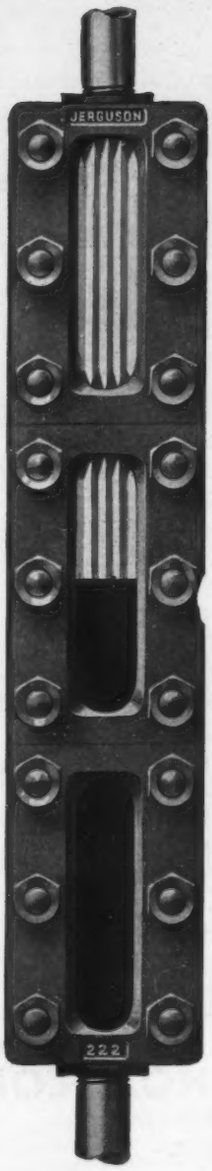
R-12-Gray

JERGUSON

REFLEX GAGES

have been used for steam boilers for 25 years and are now being used by leading oil companies for indicating oil levels in tanks, towers, stills, etc.

The *empty* space appears WHITE



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They are safe and durable at the highest pressures and temperatures. We can furnish gages with or without valves for every type of service. Full information upon request.

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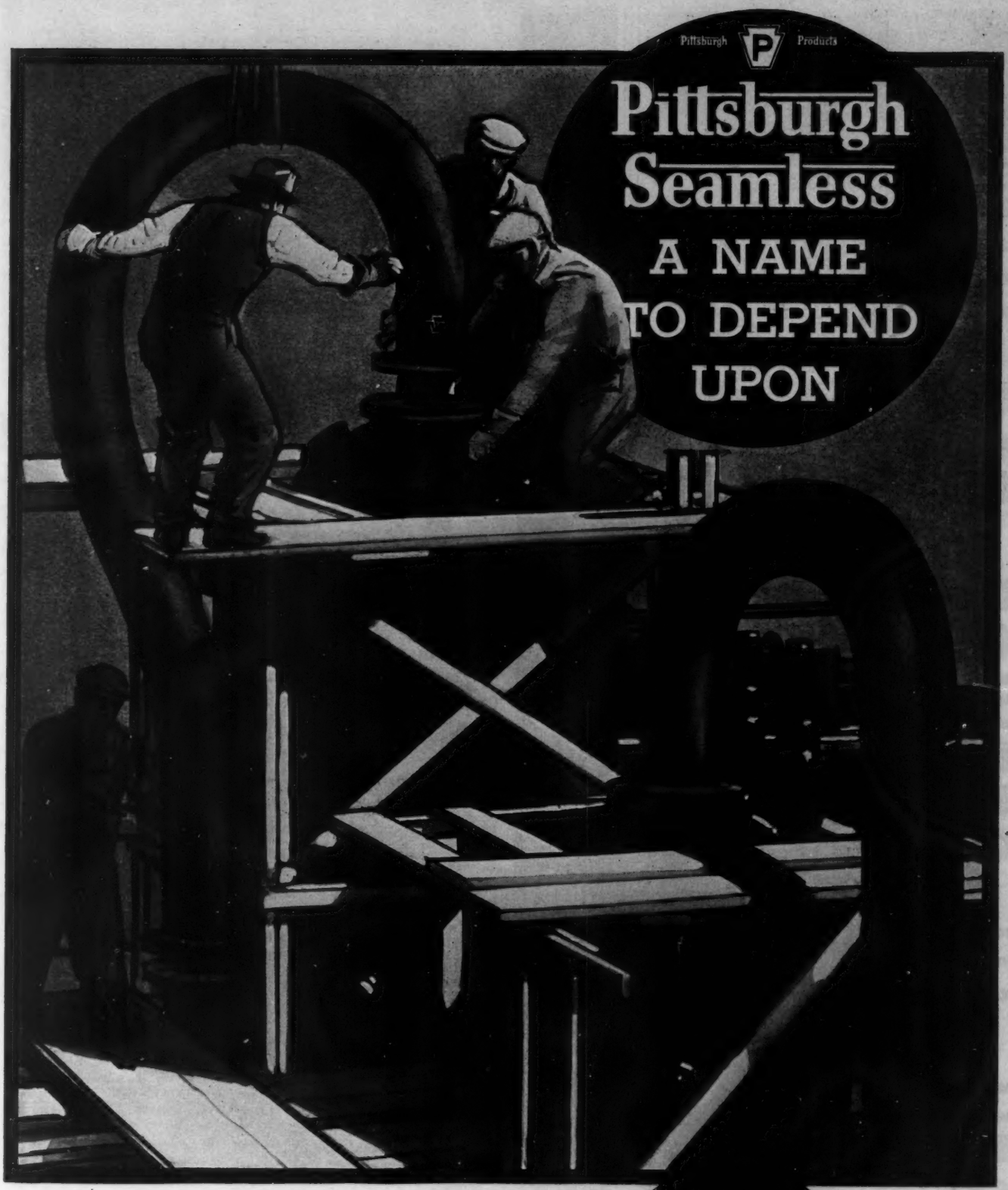

PITTSBURGH STEEL COMPANY

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Complete protection for your workmen

Weighs only 5¼ pounds . . . equipped with a canister with chemicals for absorbing or rendering harmless all poisonous or obnoxious industrial gases . . . has a TIMER that automatically records the respirations and shows at a glance when a new canister is required —an exclusive safety feature . . . Incorporates every advantage including non fogging lenses, facepiece and connecting tube of scientifically treated black rubber . . . Permits natural breathing, hearing, talking and free movement of head . . . the only canister mask officially approved by the U.S. Bureau of Mines for carbon monoxide protection. Ask for descriptive literature.

The famous Kops type facepiece of special composition black rubber assures a gas tight fit on any face.

Replaceable Head Straps are all-rubber—assure quick adjustment and provide the correct tension to the mask for absolute gas tightness.

Special Exhalation Valve is tried, proved and perfected . . . meets the rigid requirements of the U.S. Chemical Warfare Service regarding leakage.

MINE SAFETY APPLIANCES CO.

Braddock, Thomas and Meade Streets, Pittsburgh, Pa.

District Representatives in Principal Cities

M. S. A. EQUIPMENT includes Breathing Apparatus . . Inhalators . . Masks of All Types . . Gas Indicators . . Eye and Head Protectors . . Edison Electric Cap Lamps . . Safety Clothing . . First Aid Equipment . .

FLEXITALLIC GASKETS

A *cross-section of a* Flexitallic Gasket *is well worth a look*

. . . for, with nothing more than a section, it is possible to visualize *how the Flexitallic Gasket does its work.*

The V-shaped central crease in each ply of the metal ribbon can be seen as an active, self-adjusting spring, constantly pushing to form a perfect seal.

The reinforcements, identifiable in the illustrations where the metal plies are doubled, can be seen as in active service, lending strength. The V-shaped creases of the two outer reinforcements are actually clinched together, keeping the Flexitallic Gasket intact, preventing spread.

Send for a segment and for literature describing Flexitallic features of construction.

We'll refer you to Flexitallic users with plants near yours.

Ask the engineers in our customers' plants whether Flexitallic Gaskets pay their own way. Ask them point blank whether it will pay you to use them.

We'll cite outstanding performances.

Recently in a sugar plant there was trouble with the seal on processing tanks. Gasket trouble. Finally the problem was brought to the local Flexitallic representative who had us make an oversize but otherwise perfectly standard Flexitallic Gasket. No more problem.

And we'll give you a cut segment.

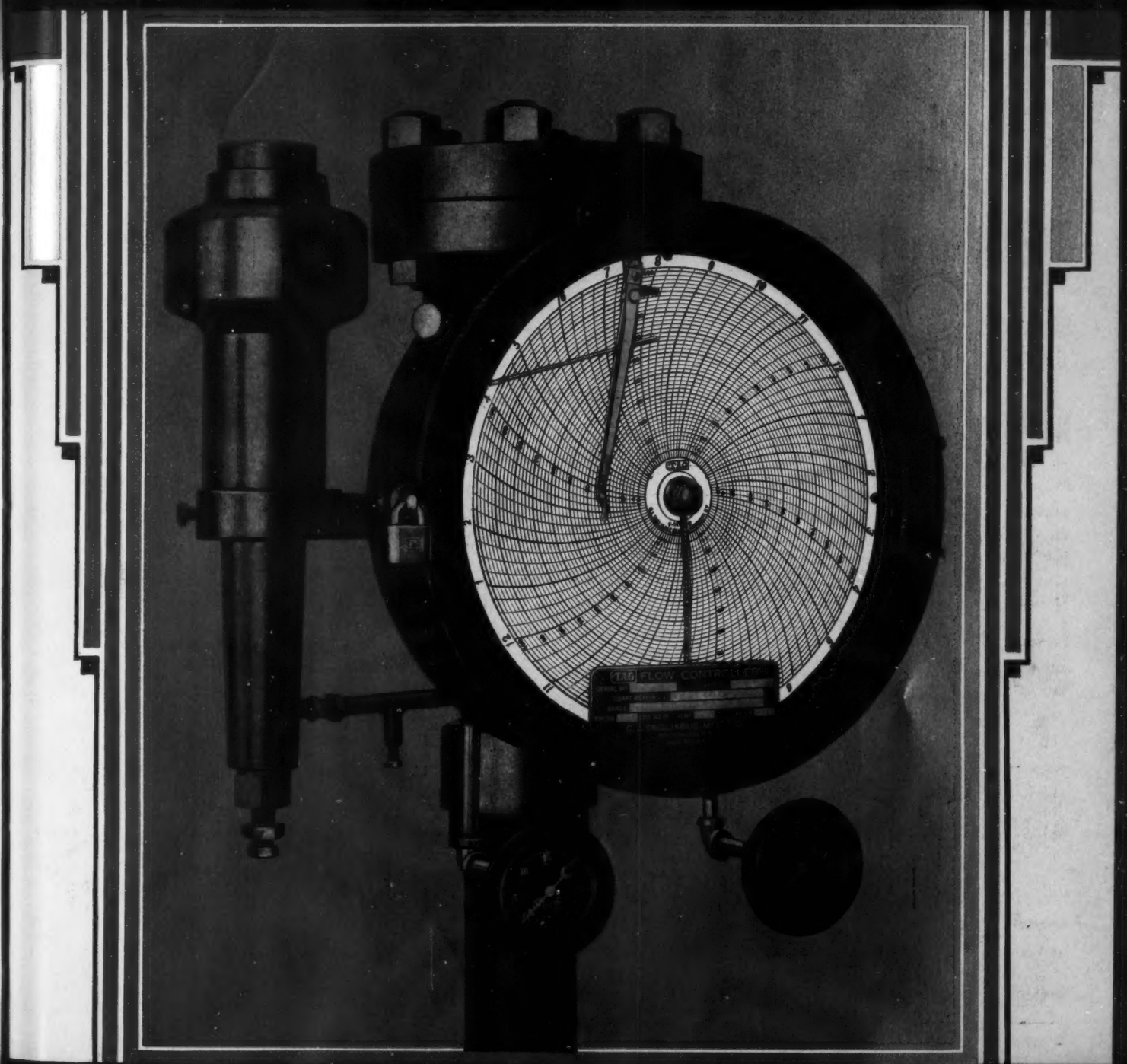
Examine it, take it apart, picture it in service. Many are the Flexitallic users who convinced themselves just that way!

"Flexitallic" Reg. U.S. Pat. Off. Gaskets

FLEXITALLIC GASKET COMPANY

8th and Bailey Sts. • Camden, N. J.

ONLY TAG GIVES TO YOU . . .



The Ideal Manometer

Combined With

A Super Controller

TAG Magnetic Clutch

The Ideal Manometer

THE O.K. of the Oil Industry is never lightly bestowed. TAG Magnetic Clutch Flow Instruments have won it. By their performance on hundreds of installations they have earned from engineers and operating men the superlative endorsement . . . "TAG is the ideal instrument for our work." Why is TAG supplanting the old pressure-tight bearing design?

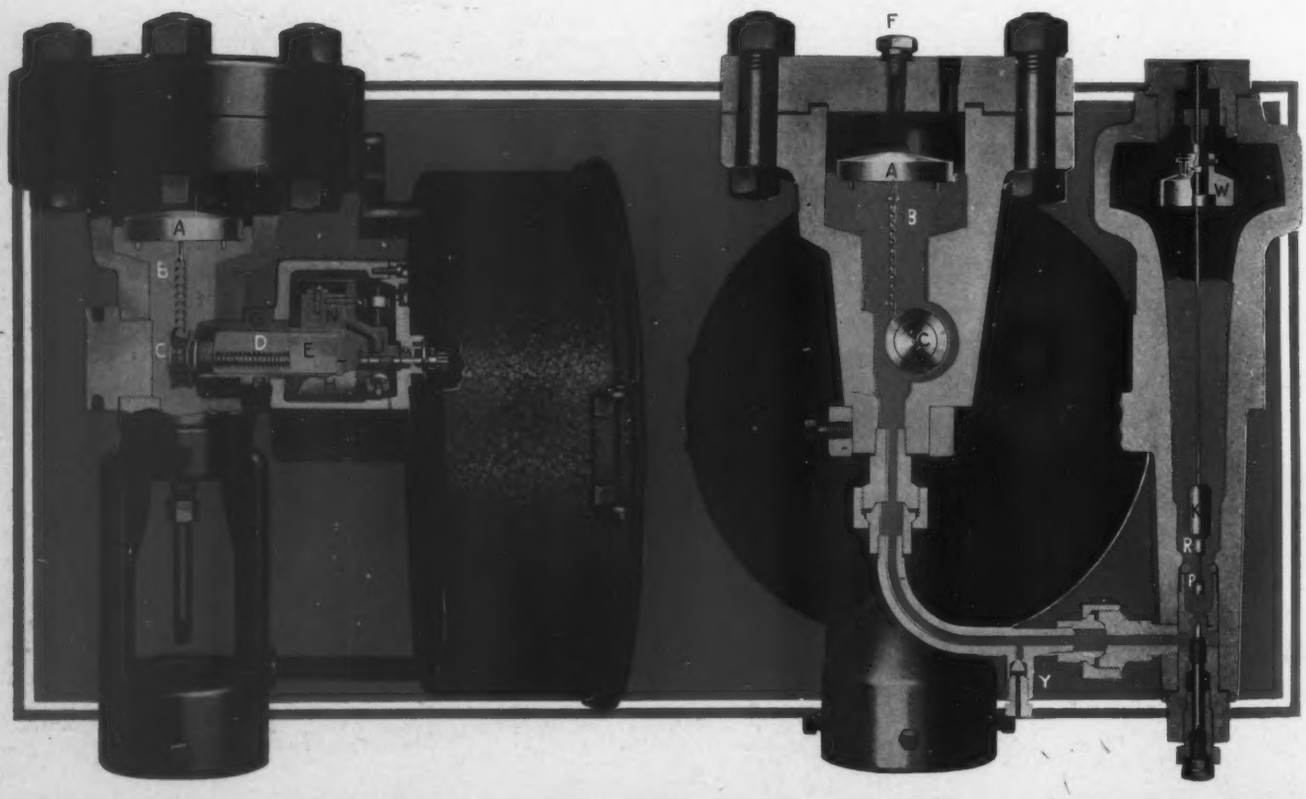
1. **Safety First**—No stuffing box to leak or bind . . . 2500 pounds Standard Construction . . . Forged steel manometer.

2. **Corrosion-Proof**—No stuffing box permits the submerging of all working parts in mercury during operation.

3. **Better Accuracy**—No stuffing box, instead magnetic clutch, which is virtually frictionless, REGARDLESS of operating pressure.

4. **Less Maintenance**—No stuffing box, hence no lubricator to service . . . Longer life because of corrosion-proof design.

5. **Less Installation Expense**—No sealing chambers required for corrosive fluids . . . Universal mounting for flush, wall or pipe stand.



C. J. TAGLIABUE MFG. CO.,

TAG Damplifier (Damped Amplification)

A Super Controller

TAG who pioneered automatic control in industry, sums up years of experience in the *TAG Damplifier*. From the featherweight flapper to the familiar TAG Ball Air Valve it is made up of time-tested elements, simply and logically arranged. And its unique *Damped Amplification* gives you the ultimate in an air-operated controller.

1. **Straight Line Control**—No "hunting" . . . Perfectly balanced control action . . . *Damped Amplification* prevents any over-control tendency.

2. **No Overswings Coming into Control**—After a decided change in conditions causing a considerable departure of control from setting point and also when operator resets controller at a new point, controller will smoothly pick up setting without a series of overswing cycles.

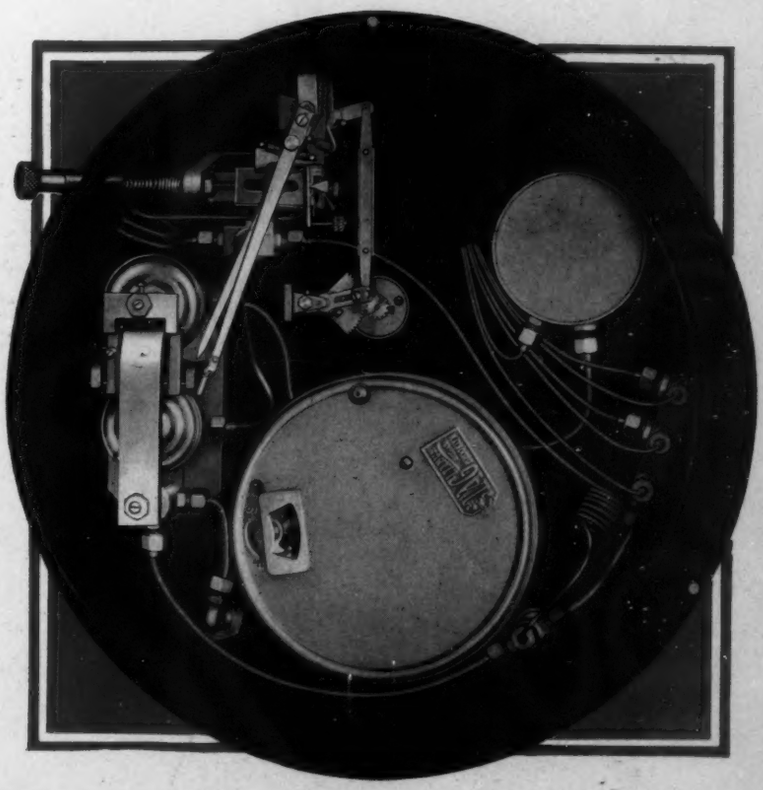
3. **Unaffected by Load Changes**—The *TAG Damplifier* can maintain the diaphragm valve in any position between open and shut while maintaining the setting point unchanged.

4. **100% Automatic**—Naturally the *TAG Damplifier* needs no assistance from hand regulation of by-pass . . . It is competent to take complete charge of the job without help.

5. **Unaffected by Air Supply Variations**—Air supply pressure can vary (down to actual air pressure on diaphragm valve) without influencing control behavior.

6. **Outside Setting Pointer Adjustment**—Adjusting knob for setting pointer is outside so that door need not be opened when operator wishes to change control point.

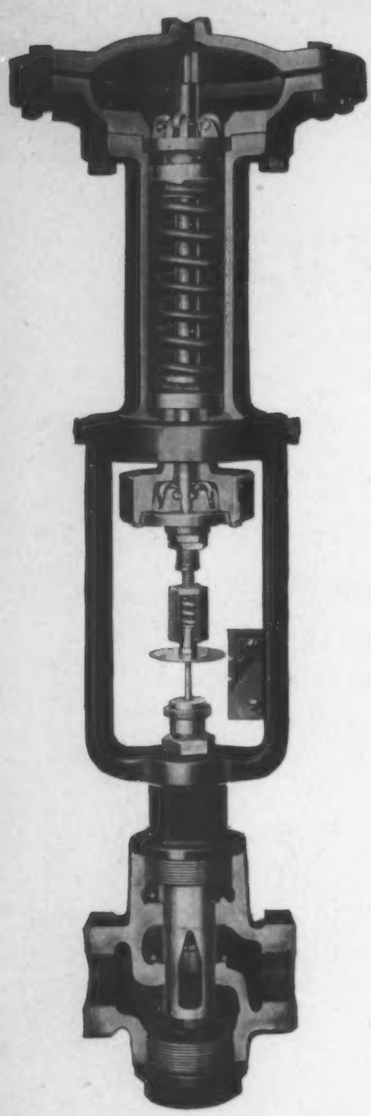
7. **Uniform Chart Divisions**—Volumeter manometer with parabolic curved cross-section gives uniform chart in units of flow, assuring uniform control accuracy and action throughout range . . . Conventional straight side manometer optional.



In Your Modernization Program, Use Modern Flow Instruments

Park and Nostrand Aves., Brooklyn, N.Y.

...and the TAG Friction-Free Valve Finishes the job right



THE business end of a control system is the diaphragm valve. The TAG Friction-Free Valve reduces friction to the minimum. The stroke of the small diameter spindle through the stuffing box is perfectly guided by the two roller bearing assemblies through which the large diameter, upper portion of the spindle, passes. Other features are the enclosed spring and diaphragm chambers, the convenient adjustments and the position indicator. The valve itself is the high lift V-port type.

TAG Line

Controllers
Temperature
Pressure
Level
Flow

Recorders
Temperature
Pressure
Level
Flow

Thermometers
Dial-Indicating
Laboratory
Industrial

Pyrometers
Controlling
Indicating
Recording

Oil Testing Instruments

Gas Analysis Recorders

Vacuum Gages

C. J. TAGLIABUE MFG. CO.
Park and Nostrand Avenues
Brooklyn, N. Y.

C. J. TAGLIABUE MFG. CO.,
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Without obligation, of course, please send us new Flow Instrument Catalog No. 1065.

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Can your present cracking unit deliver the kind of fuel oil you need?

The TVP unit can! A wide range of gravities and viscosities is available at all times by simple operating control of the unit during cracking.

TVP fuel oil of 10.5° to 11.5° A.P.I. is being used to cut back heavy lube still fluxes to produce road oils of all standard specifications.

TVP fuel oil receives a premium for this use.

TVP fuel oil is being controlled to meet unusual requirements—example—viscosity not over 500 seconds Saybolt Furol at 10° F., a free-flowing oil in midwinter cold.

And of course, always, high yields of gasoline of high octane at 437° E. P., and even higher octane at lower endpoints.

TVP PROCESS

90 West St., New York, N. Y

REG. U.S. PAT. OFF.
TONCAN
COPPER
MO-LYB-DEN-UM
IRON PIPE

FIGHTS SALT CORROSION

ALONG the cat-walk leading from the tanker at anchor to the bulk plant on shore stretch lines of Toncan Iron Pipe. Why? Because it is universal experience that where ferrous metal is subjected to the action of salt air or salt water, the resistance of Toncan Iron to salt corrosion makes its use practically imperative. That's why Toncan Iron Pipe is found aboard the sister ships, T.S.S. Washington and Manhattan, and in any number of other ocean-going vessels, including freighters, tankers, tug boats, dredges and yachts.

Toncan Iron is an alloy of refined iron, copper and molybdenum. Among the ferrous metals, its resistance to the elements that cause rapid failure of less hardy materials is surpassed only by that of the much more costly stainless alloys. Its resistance is not confined to the surface of the metal or to segregated areas—it is uniform throughout the entire area and thickness.

All of which is just another way of saying that—where salt corrosion is encountered, take no chances. Use the pipe—or the sheet metal—or the culvert—or the boiler tube that will give you the best service for your dollar—use Toncan Iron.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES YOUNGSTOWN, OHIO

If You Are Interested in HOMOGENEOUS ASPHALT AT LOWER COST – *Look into the*

COUBROUGH* PROCESS

NEW in principle... proved in operation... the Coubrough Process* opens the way to lower costs — and greater profits — in the production of high grade asphalt.

The Coubrough Process* is continuous, economical — and flexible. It produces high yields of homogeneous asphalt of any desired penetration, from any type of asphaltic or mixed base crude .... For executives who are not yet familiar with the Coubrough Process* we have some very interesting data on yields and costs.

*The Coubrough Process is covered by U.S. Patent No. 1,905,156 and other patents allowed and pending.

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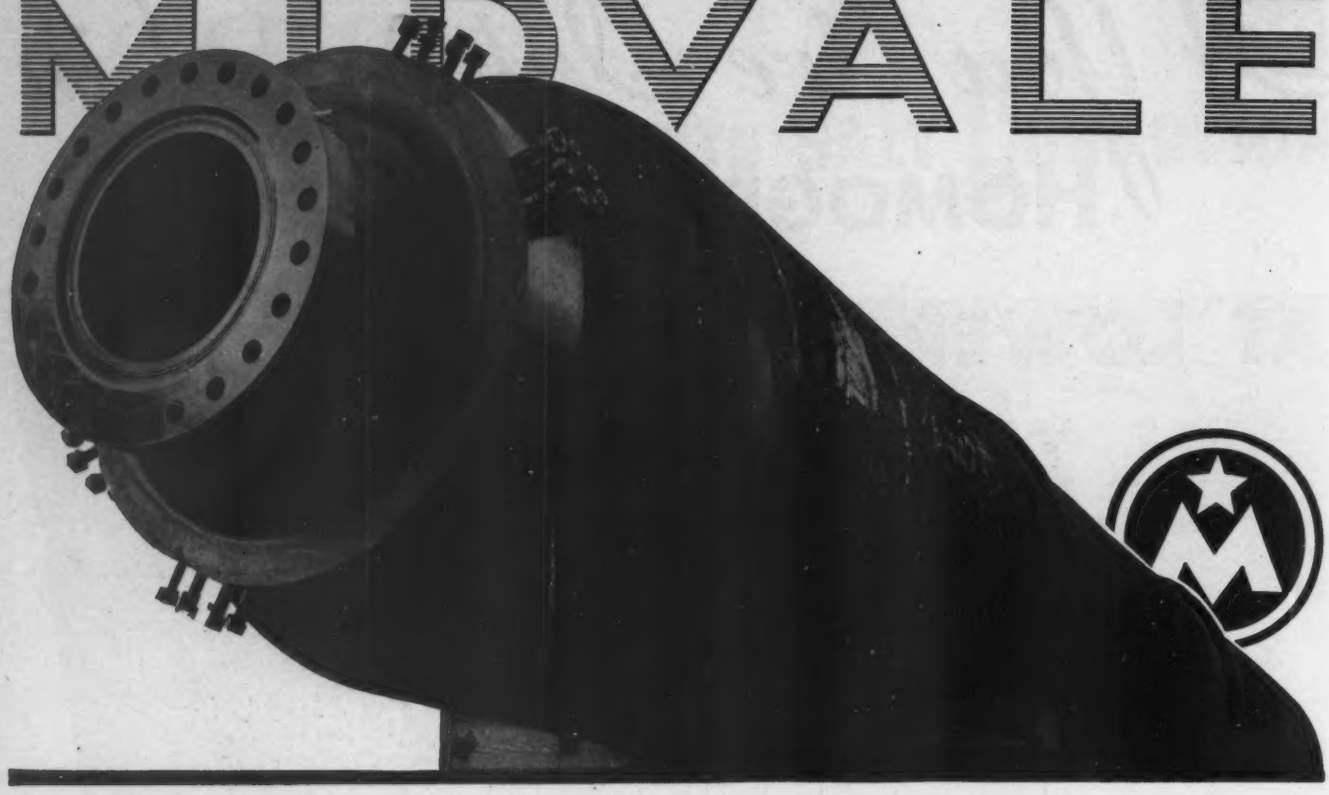
THE LUMMUS COMPANY
50 CHURCH ST., NEW YORK, N. Y.

LUMMUS

PETROLEUM REFINING PLANTS

MIDVALE



« NO SEAMS « NO JOINTS

FORGED

FROM A SINGLE INGOT

No seams, no joints where there might be a question mark instead of a known factor—Midvale forges *seamless* pressure vessels, made from a single steel ingot!

Builders and operators of high-pressure cracking units are interested in the strongest, the safest type of vessel that can be produced. Midvale was a pioneer in this type of vessel, and Midvale's research laboratory and experienced shop men continue to carry pressure vessels' capacity to higher limits—over wide ranges of diameters, lengths and wall thicknesses.

THE MIDVALE COMPANY • NICETOWN, PHILADELPHIA

District Offices: **New York Pittsburgh Washington Cleveland Chicago San Francisco**

Efficient Pumping

against low heads at high speeds

HYDRODYNAMIC research has made possible the De Laval Propeller Pump, by means of which large volumes can be pumped efficiently against low heads. This pump operates at electric motor and steam turbine speeds.

The pump is exceedingly simple and compact and is so arranged that all parts are readily accessible and renewable without disturbing piping. Parts are interchangeable, being made to limit gages.

The De Laval Propeller Pump is ideal for circulating condenser cooling water, in fact for all purposes within the head limitation of about 40 ft.

Propeller, shaft and bearing. The renewable sleeve, which protects the casing from wear, and the guide vanes are here shown moved back from their working positions in order to show the propeller.

De Laval Steam Turbine Co.

Trenton, New Jersey

LOCAL OFFICES

Atlanta, Boston, Charlotte, Chicago, Cleveland, Duluth, Edmonton, Alberta, Havana, Helena, Honolulu, H. I., Houston, Kansas City, Los Angeles, Manila, P. I., Montreal, New Orleans, New York, Philadelphia, Pittsburgh, St. Paul, Salt Lake City, San Francisco, Seattle, Toronto, Vancouver

Manufacturers of Steam Turbines, Centrifugal Pumps, Propeller Pumps, Rotary Displacement Pumps, Centrifugal Blowers and Compressors, Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery

3158

POP AND LAD WATCH WELDING OF STAINLESS STEEL TOWER

"This, Lad, to my knowledge is the first fractionating tower of arc-welded stainless steel construction. Every bit of metal in it except its base is stainless steel, including its twenty-nine trays.

"The tower is 59 feet 6 inches high, 6 feet 6 inches in diameter, with shell of ⅜-inch plate. Every joint in the shell and trays is welded by the shielded arc.

"To my mind this bubble tower is a tribute to the progressiveness and engineering skill of the Foster Wheeler Corporation who are building it."

"You're right, Pop, and it's also a tribute to the shielded arc process of welding which made possible welds having the same physical characteristics as the stainless steel.

"With Lincoln welders and *'Stainweld'* electrodes, as used by the Foster Wheeler Corporation, you get just such welds. That's why in many large refineries and fabricating shops you'll find Lincoln welders and *'Stainweld'* electrodes being used for welding stainless steel."

● *For complete information on welding procedure for stainless steel write to*

LINCOLN

THE LINCOLN ELECTRIC COMPANY, CLEVELAND, OHIO

Largest Manufacturers of Arc Welding Equipment in the World

W-59

AMERICAN USS STAINLESS AND HEAT RESISTING STEEL SHEETS AND LIGHT PLATES

AMERICAN SHEET AND TIN PLATE COMPANY PITTSBURGH
TRADE MARK REG. U.S. PAT. OFF.

SPECIALLY ADAPTED TO THE REFINING FIELD

Indicate your particular field—industrial, chemical, refining, manufacturing, food handling, architectural, domestic—and your specific use, and our staff of technicians who are specializing on these STAINLESS Steel alloys will recommend a grade appropriate in cost and adapted to your requirements.

Chromium-Alloy Steels *Ferritic*		Chromium-Nickel Steels *Austenitic*
USS 12 USS 17 USS 27	Inquiries regarding any application of sheets or light plates, or any product fabricated from either, will be given careful attention. Send for literature. *USS Chromium-Nickel Alloy Steels are produced under licenses of the Chemical Foundation, Inc., New York; and of Fried. Krupp A.G. of Germany.*	USS 18-8 USS 18-12 USS 25-12

AMERICAN SHEET and TIN PLATE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

USS Stainless Steel Products also manufactured by following Subsidiary Companies of United States Steel Corporation:

AMERICAN STEEL & WIRE CO., Chicago — *Cold Rolled Strip and Wire Products*

ILLINOIS STEEL CO., Chicago, and CARNEGIE STEEL CO., Pittsburgh — *Bars, Plates, Special Sections and Semi-Finished Products*

NATIONAL TUBE COMPANY, Pittsburgh — *Pipe and Tubular Products*

NOW . . .

A NEW Oil-Immersed, Weatherproof Combination Magnetic Switch

G-E Explosion-Proof Control for Oil Refineries

CR7006, Size 1, magnetic switch, 7½ hp., 440 volts, 3 phase

CR7006, Size 2, magnetic switch, 25 hp., 440 volts, 3 phase

CR7006, Size 3, oil-immersed magnetic switch, 50 hp., 440 volts, 3 phase

CR1062-E3B motor-starting switch, 7½ hp., 440 volts, 3 phase

CR1061-B1C motor-starting switch, ½ hp., single phase

CR2941-E1 oil-immersed push-button station

CR2941-A1 push-button station

Built to Underwriters' Laboratories Specifications

The seven types of G-E explosion-proof control shown in this box are built to the standards of and tested by, the Underwriters' Laboratories for Class I, Group D, hazardous gas locations.

Will Withstand an Internal Explosion

This control is built to the Underwriters' Laboratories specifications for the air-break type, with wide joints and ample strength to withstand an internal explosion and prevent any flame from escaping from the device.

Oil-immersed Types for Corrosive Atmospheres and Outdoor Service

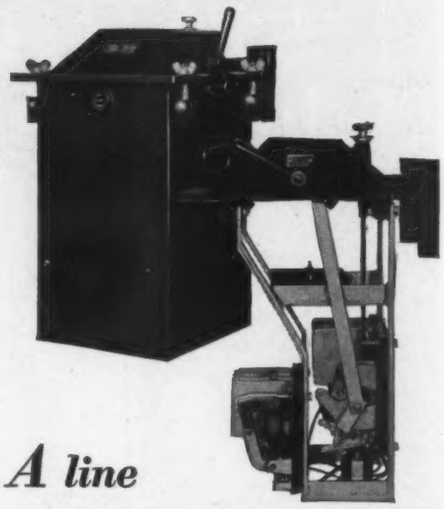
The oil-immersed types, which are suitable for outdoor service, use oil to protect the contacts from corrosive atmospheres and to permit more compact construction.

Includes Features of Standard Control

G-E explosion-proof control incorporates the electrical features and advantages of G-E standard general-purpose control. All the magnetic- and manual-starting switches shown have thermal overload protection. The push-button stations are of strong construction, with ample clearances to give trouble-free service.

New Publications Available

Request copies of our recent publications on explosion-proof control, GEA-1588 and GEA-1716, from the nearest G-E sales office, or address General Electric, Schenectady, N. Y.



A line switch and a magnetic starter all in one compact unit

NOW, General Electric rounds out its line of oil refinery control with this new oil-immersed combination magnetic switch that has every feature oil men asked for.

Compact—an oil-immersed starter with temperature overload relay and a motor circuit switch, all under one cover. Just one unit to install. Consider the saving. Saves space, too.

Corrosion-resisting—starter, switch, and relay are immersed 6 in. under oil. Corrosive elements can't get in. Ideal for outdoor use. Complete switch is housed in an arc-welded sheet-metal tank with a heavy, cast-iron, dome-shaped cover.

Fool-proof—positive interlock on motor-circuit switch prevents operator from lowering tank for inspection unless switch is open.

Ask an oil-field specialist in the nearest G-E office for complete information on this money-saving switch. General Electric, Schenectady, N. Y.

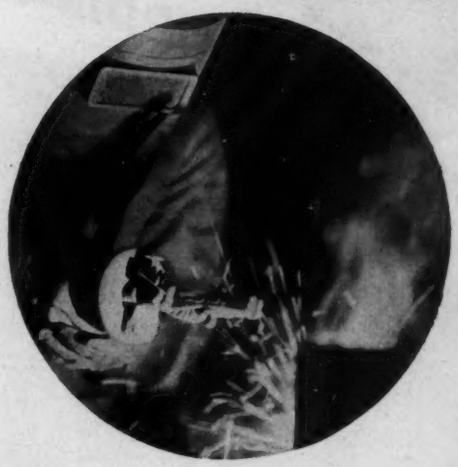
301-159

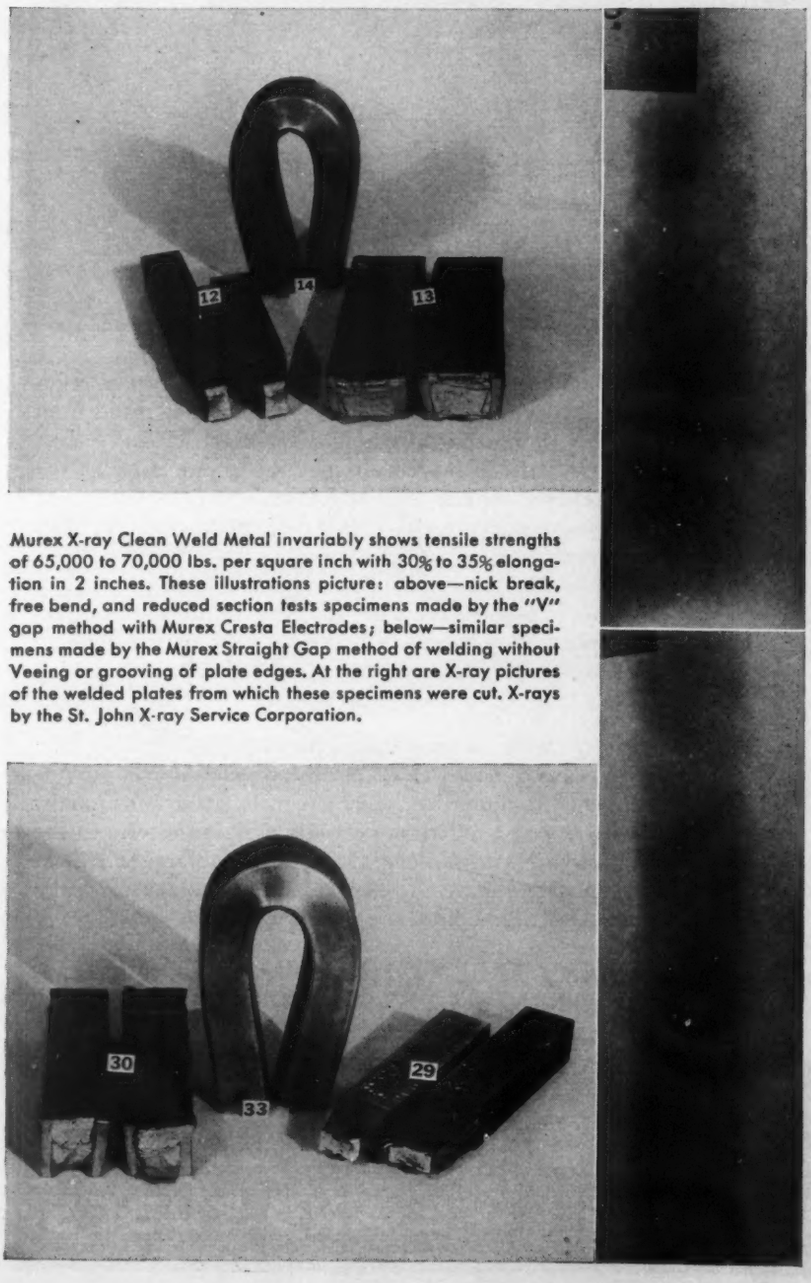
GENERAL ELECTRIC

Lower Welding Costs

WITH MUREX *X-ray-Clean* WELD METAL

Murex Welding is economical welding. Murex Electrodes deposit weld metal that consistently shows up clean under the X-ray. Expensive cutting out, re-welding and re-X-raying of poor seams is reduced to a minimum. Welding costs drop correspondingly.





Murex X-ray Clean Weld Metal invariably shows tensile strengths of 65,000 to 70,000 lbs. per square inch with 30% to 35% elongation in 2 inches. These illustrations picture: above—nick break, free bend, and reduced section tests specimens made by the "V" gap method with Murex Cresta Electrodes; below—similar specimens made by the Murex Straight Gap method of welding without Veeing or grooving of plate edges. At the right are X-ray pictures of the welded plates from which these specimens were cut. X-rays by the St. John X-ray Service Corporation.

And, Murex Heavy Mineral Coated Electrodes assure still further economies by being more efficient. They deposit more metal per hour as well as per pound of electrodes used.

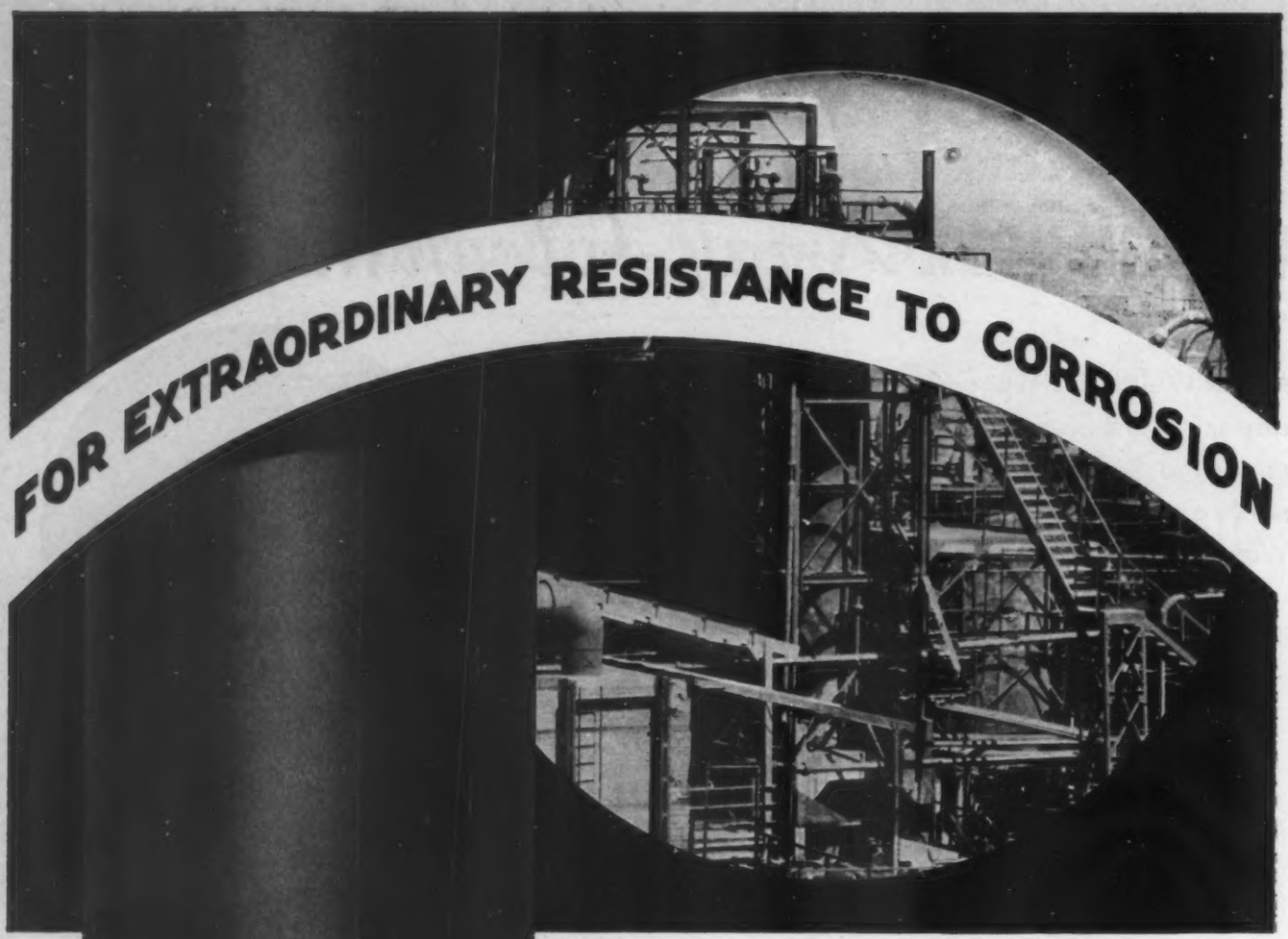
Welders who use Murex will tell you, too, that Murex Electrodes make welding easier. They require no fussy technique. They burn with less spatter and produce smooth welds that are more readily cleaned. They reduce eye strain and give off no objectionable fumes or smoke.

The complete line of Murex Electrodes, the physical properties of Murex deposited metals and other features are described in a comprehensive booklet. May we send you a copy?

METAL & THERMIT CORPORATION
120 Broadway New York, N. Y.
Albany, Chicago, Pittsburgh, S. San Francisco, Toronto

MUREX

HEAVY MINERAL COATED ELECTRODES



FOR EXTRAORDINARY RESISTANCE TO CORROSION

Cracking still tubes, hot oil lines, and other tubular parts of refinery equipment will give much longer service if made from NATIONAL U S S 18-8 Stainless and Heat Resisting Pipe and Tubes. This superior material is made by the seamless process from the finest quality electric-furnace steel of chromium-nickel alloy and affords a resistance to corrosion never before experienced. Frequent shut-downs are eliminated and replacements are reduced to a minimum when NATIONAL Stainless Pipe and Tubes are used. This is a report of experience. You, too, can secure the same results in your plant. Try them and find from your own experience the new measures of safety, economy, and durability resulting from their use.

Available in a wide range of diameters, wall-thicknesses, and lengths. Can be easily bent, welded, or otherwise fabricated. Produced with unrivaled facilities, by the largest manufacturers of tubular products in the world, offering a complete piping service to the refining industry. NATIONAL engineers and metallurgists will be glad to aid in determining the best application to any particular requirement. Descriptive literature on request.

ADVANTAGES

Seamless—No welds.
High resistance to corrosion.
Maximum strength at high temperatures.
Unusual resistance to oxidation or scaling.
Dependable uniformity of structure.
Accurately controlled heat treatment.
Sentry Drilled (when ordered) an exclusive feature.

U S S Chromium-Nickel Alloy Steels are produced under the licenses of the Chemical Foundation, Inc., New York, and Fried. Krupp A. G. of Germany.

NATIONAL TUBE COMPANY · Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

NATIONAL USS STAINLESS AND HEAT RESISTING PIPE AND TUBES

CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Valves

The Edwards Valve & Manufacturing Company, Inc., has issued another section of its Catalog No. 11. Section C covers cast steel valves in globe and angle, stop, check, and feed line stop-check designs. All standard series from 300-pound to 1500-pound wsp are completely described with full specifications, dimensions and list prices.

Pyrometer

The Foxboro Company, Foxboro, Mass., has prepared Bulletin 190 dealing with its new recording potentiometer pyrometer, giving full detailed engineering information and description of construction features and specifications.

Instruments

The Brown Instrument Company, Philadelphia, is distributing Catalog 6702, describing Brown thermometers and pressure gauges, available in indicating, recording and controlling types. Specifications, construction features are described in detail. Accessories are included. Also a folder describing the Brown Recording CO_2 Meter.

Cooling Tower

The Marley Company, Kansas City, Mo., has issued Catalog No. 41, describing Marley forced draft spray cooling towers, spray nozzles, multiblade fans, drift eliminators, and Marley small mechanical draft towers. Well illustrated, showing many applications.

Controllers

Kieley & Mueller, Inc., 34 West 13th St., New York, is distributing Bulletin C, 24 pages on float type liquid level controllers.

PULMOSAN SAFETY DEVICES

- RESPIRATORS
  Dust—Smoke—Fumes
- GOGGLES
- FIRE FIGHTING

Write for complete file of safety data.

PATENTED
PULMOSAN SAFETY EQUIPMENT CORPORATION
176 Johnson St.
Brooklyn, N. Y.

EVERYTHING for SAFETY

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

WANTED: Sales Engineer to sell valves and fittings to the refinery trade. *Necessary Qualifications:* Pleasing personality; a background of chemistry, metallurgy, and mechanical engineering; a knowledge of product application to the oil industry. In reply state schooling, experience, and salary expected. Address: Box 1034 The Refiner, Houston, Texas.

Air Ejectors

Ingersoll-Rand Company, 11 Broadway, New York, N. Y., is distributing a two-page leaflet describing its line of air ejectors, from small single-stage ejectors to immense thermal compressors used in refrigeration and evaporation work.

Compressors

Gardner-Denver Company, Quincy, Illinois, has issued Bulletin AA-6, seventh edition, 24 pages, presenting Class AA vertical water-cooled compressors embodying best features of preceding lines with many improvements. These compressors were designed primarily for direct connection to electric motors or multi-cylinder engines, but can also be furnished for standard flat-belt, V-belt, or similar drive.

Electrical Equipment

Crocker-Wheeler Electric Manufacturing Company, Ampere, New Jersey, has issued a 12-page booklet illustrating and describing alternating-current motors, polyphase induction motors, direct-current motors, generators, motor generator sets, speed changers, flexible couplings, and torquemeters.

Conveyors

The Fuller Company, Catasauqua, Pennsylvania, is distributing a 36-page loose-leaf general catalog covering description and uses of the Fuller-Kinyon system of conveying pulverized materials, etc.

Dehydrator

National Radiator Corporation, Cast Products Division, Johnstown, Pennsylvania, is distributing Report CP-8, a 53-page engineering report on the development and tests of an oil emulsion dehydrator developed by the company.

Chromium Steel

Republic Steel Corporation, Central Alloy Division, Massillon, Ohio, has prepared a well illustrated subject booklet giving a fund of authentic information on Enduro 4-6% chromium steels, which are corrosion resistant, resist acid and scaling at elevated temperatures and which can be rolled, formed, drawn, forged, welded or riveted into almost any shape desired, and are available in sheets, plates, hot and cold rolled strip, etc.

Regulation Equipment

The Strong, Carlisle & Hammond Company, 1392 West Third St., Cleveland, Ohio, has issued Bulletin No. 152 describing Strong pressure regulating valves, pump governors, and quick cleaning strainers. Bulletin gives full specifications and engineering information.

Distillation Systems

The Lummus Company, 50 Church Street, New York, is distributing a subject booklet "40 Years in Distillation," in colors, describing various Lummus installations of various types in petroleum and alcohol fields, also including descriptions of its laboratories, heat exchangers, return bends, and oil heaters.

Instruments

General Electric Company, Schenectady, New York, is distributing bulletin GEA-1784, eight pages on Type AP-9 portable ammeters, voltmeters and wattmeters.

Trucks

Aluminum Company of America, Pittsburgh, Pennsylvania, is distributing a 65-page book on the uses of aluminum for truck bodies, including, as a supplement, several construction drawings and bills of material for six types of aluminum bodies.

Water Treatment

D. W. Haering & Company, 3408 West Monroe St., Chicago, is distributing a 16-page booklet on its water treating methods for boilers, air conditioning systems, etc.

Weight Feeder

The Hardinge Company, York, Pennsylvania, is distributing Bulletin 33B, four pages on the company's constant weight feeder.

Rust Preventive

Dearborn Chemical Company, 310 South Michigan Avenue, Chicago, Illinois, has ready for distribution a booklet dealing with results that their NO-OX-ID rust preventive gives in preserving steel equipment from rust. Extensive use of photographs has been made in showing tests and application methods of NO-OX-ID on tanks, pipe lines, railroad and shop equipment and structural steel installations.

USE THIS COUPON
(Address manufacturer direct)

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Please send me, without obligation, free booklet described in the December, 1933, issue of REFINER AND NATURAL GASOLINE MANUFACTURER.

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ADDRESS . . . . . .

EMPIRE
FOR ALL LIQUID PETROLEUM PRODUCTS
OIL METERS
NATIONAL METER COMPANY

NRA

There are no better meters than Empire Meters for measuring petroleum products. They are known and endorsed by oil men throughout the world. No other meters have the famous Empire Balanced Piston.

NATIONAL METER COMPANY
4213 First Avenue, Brooklyn, N. Y.
BOSTON CHICAGO SAN FRANCISCO LOS ANGELES

The NEW GALD-PROOF
THREAD DOPE
—genuine
Metallic Lead

for high temperature service in Refineries

BESTOLIFE is a new, finely divided metallic lead. Prevents thread corrosion. Permits easy breaking. Forms a thin, uniform film of lead. Absolutely gald-proof. Resists high temperature. Will not oxidize. A perfect lubricant. Makes joints freeze-proof. Send for trial order. Try it on your header studs and super-heated steam lines.

BESTOLIFE

12 lb.
$8.25
Delivered in U.S.A.
No charge if not the best you have ever used.

SEND THIS COUPON FOR DETAILS

ARMITE LABORATORIES
1902 E. 65th St., Los Angeles, Calif.
Send full information about BESTOLIFE, your new metallic lead, for Refineries.

NAME.....
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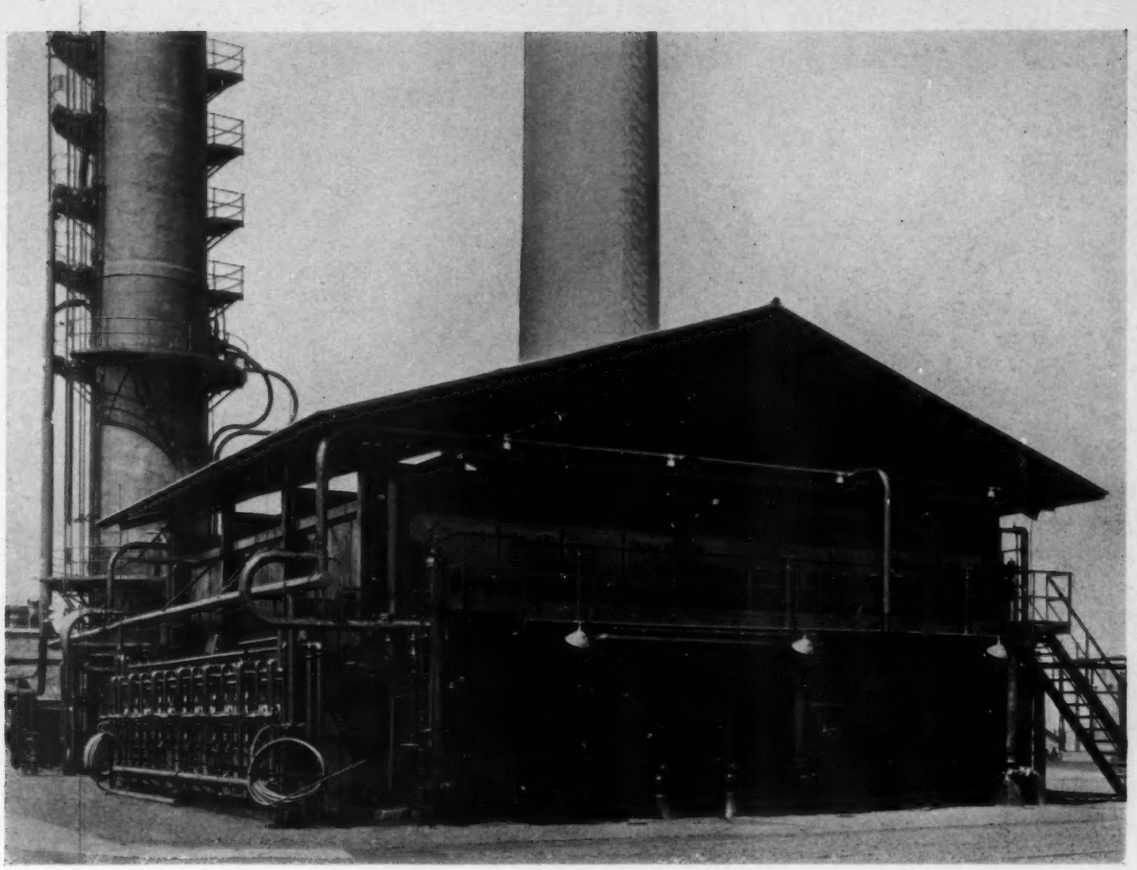


REFORMING HEATERS

The engineers of Foster Wheeler Corporation have made an intensive study of metallurgical requirements for heat transfer apparatus operating at temperatures above 1,000 degrees and pressures up to 4,500 lb. per sq. in.

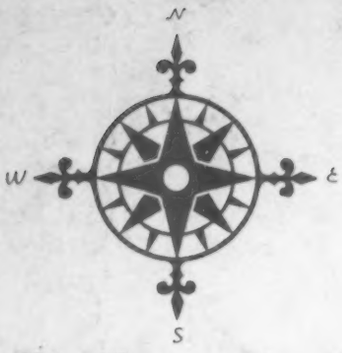
The double ended heater of a reforming unit shown here was built to withstand successfully temperatures and pressures higher than those encountered in most refineries.

The two furnaces of this heater are fired by twenty-seven combination oil and gas burners which effect a heat liberation of 100,000,000 B.t.u.'s per hour.

FOSTER WHEELER CORPORATION
165 Broadway, New York

NRA MEMBER U.S. WE DO OUR PART

FOSTER WHEELER



East, West, North, South,
the Verdict is the Same...

Here at Last is a

Slo-Self-Closing Loading Line Valve

that *Lives Up to Its Name*

Every oil engineer realizes the need of a slow-self-closing loading line valve to prevent the hammering and excessive pressure built up on the line when the valve is suddenly closed by the operator.

To meet this need, it is not enough that the valve be merely *called* slow and self-closing. It is necessary that it *live up to its name.*

The success of the McDonald Slo-Self-Closing Line Valve (Plate 945) is due to the fact that it has met the most exacting requirements in a thoroughly satisfactory way. It was offered publicly only after years of field tests had *proved* its soundness. Now, actual operation for many of the country's leading oil companies has confirmed the field tests in every detail.

This is the valve you've been looking for to prevent the loading line leaks and damage to expensive equipment which heretofore you thought you could not escape. Study the "highlights" of the new valve at the right. Then ask for descriptive folder.

NRA MEMBER U.S. WE DO OUR PART

A. Y. McDONALD MFG. CO.

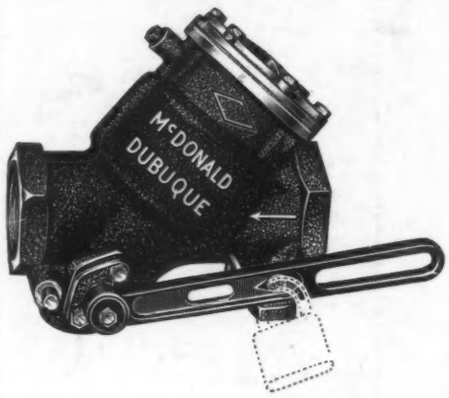
"The Home of the Swing Joint"

DUBUQUE, IOWA

Omaha Kansas City Minneapolis Sioux City Des Moines

There's a McDonald Distributor Near You

McDONALD



McDonald Slo-Self-Closing Loading Line Valve (Plate 945)

FULL FLOW—Designed to give maximum flow without restriction.

SLOW CLOSING—Hydraulic control of valve plunger eliminates excessive pressure and consequent hammering on line which takes place when ordinary valves are suddenly closed by the operator. Speed of closing may be increased or decreased for various operating pressures and viscosity of fluids handled.

EASY OPENING—This is accomplished by the parabolic cam located directly under valve plunger.

HOLD OPEN OR STAY OPEN TYPE—Some users prefer a valve which must be held open by the operator. Others desire one which need not be held open. The new valve is furnished in either type.

VALVE DISC—Made of special composition to resist action of gasoline or oil—may be easily replaced.

VALVE CAP—Easily removed — no large wrenches necessary.

NON-ROTATING STUFFING BOX GLAND—will not loosen due to turning of valve stem. Made of ample size and easily repacked. Stuffing box on non-pressure side reduces hazardous leaks.

HANDLE STOP AND LOCK LUG—Integrally cast with body. Padlock may be easily inserted to prevent tampering.

All bronze with exception of malleable iron handle and steel cam shaft and roller. All exposed screws are cadmium plated.